TWENTY-THIRD REPORT OF THE ONTARIO BUREAU OF MINES:

PARTS I-II.

1914

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Section
No 873

TWENTY-THIRD ANNUAL REPORT

OF THE

ONTARIO BUREAU OF MINES, 1914,

BEING

VOL. XXIII.

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LETTER OF TRANSMISSION

To His Honour Sir John Morison Gibson, Etc., Etc., Etc.,
Lieutenant-Governor of the Province of Ontario.

Sir,—I have the honour to transmit herewith, for presentation to the Legislative Assembly of the Province of Ontario, the Twenty-third Annual Report of the Bureau of Mines.

I have the honour to be, Sir,

Your obedient servant,

W. H. Hearst,
Minister of Lands, Forests and Mines.

Department of Lands, Forests and Mines,
Toronto, March 31st, 1914.

INTRODUCTORY LETTER

To The Honourable William Howard Hearst,
Minister of Lands, Forests and Mines, Toronto.

Sir,—I beg to hand you herewith, to be presented to His Honour the Lieutenant-Governor in Council, the Twenty-third Annual Report of the Bureau of Mines, being for the calendar year 1913.

The production of minerals in 1913 was the largest on record, showing an increase in value over that of 1912 of ten per cent. During the last ten years the mines and mineral works of the Province have increased their output by 313 per cent., and during the past five years by 112 per cent. In 1913, gold shows the largest gain among the metals, 106.1 per cent., and Portland cement among the non-metallic substances, 21.9 per cent. The metallic production represents 70.5 per cent. of the whole. The yield of gold in 1913 was almost equal to the entire production of the metal from the time the first discovery was made in 1866 to the end of 1912. While there was a falling off in the production of silver from Cobalt, the mines show a wonderful record, the output since their discovery ten years ago representing two tons of silver for every working day during that period.

Part I, in addition to the statistical review of the mineral industry, contains descriptions of the mines of Ontario by Mr. T. F. Sutherland, Chief Inspector of Mines. A paper by Dr. A. P. Coleman describes the structural and age relations of the pre-Cambrian rocks north of Lake Huron, which are of great interest from both the scientific and economic points of view. Mr. G. R. Mickle, Mine Assessor, in co-operation with Professors W. H. Ellis, J. W. Bain and E. G. R. Ardagh, contributes an important paper on The Chemical Composition of Natural Gas Found in Ontario. This paper adds many interesting facts to our knowledge of this valuable substance.

In Part II Messrs. A. G. Burrows and P. E. Hopkins describe the Kirkland Lake and Swastika Gold Areas, which have during recent months attracted much attention.

A very important event of the year was the meeting of the Twelfth International Geological Congress. The sessions were held in Toronto in August, excursions to various points of Ontario and to other Canadian Provinces being made both before and after the sessions. The meeting did much to make Ontario's geology and mineral resources known to the nations of the world.

I have the honour to be, Sir,

Your obedient servant,

Thos. W. Gibson,
Deputy Minister of Mines.

Department of Lands, Forests and Mines,
Toronto, March 31st, 1914.

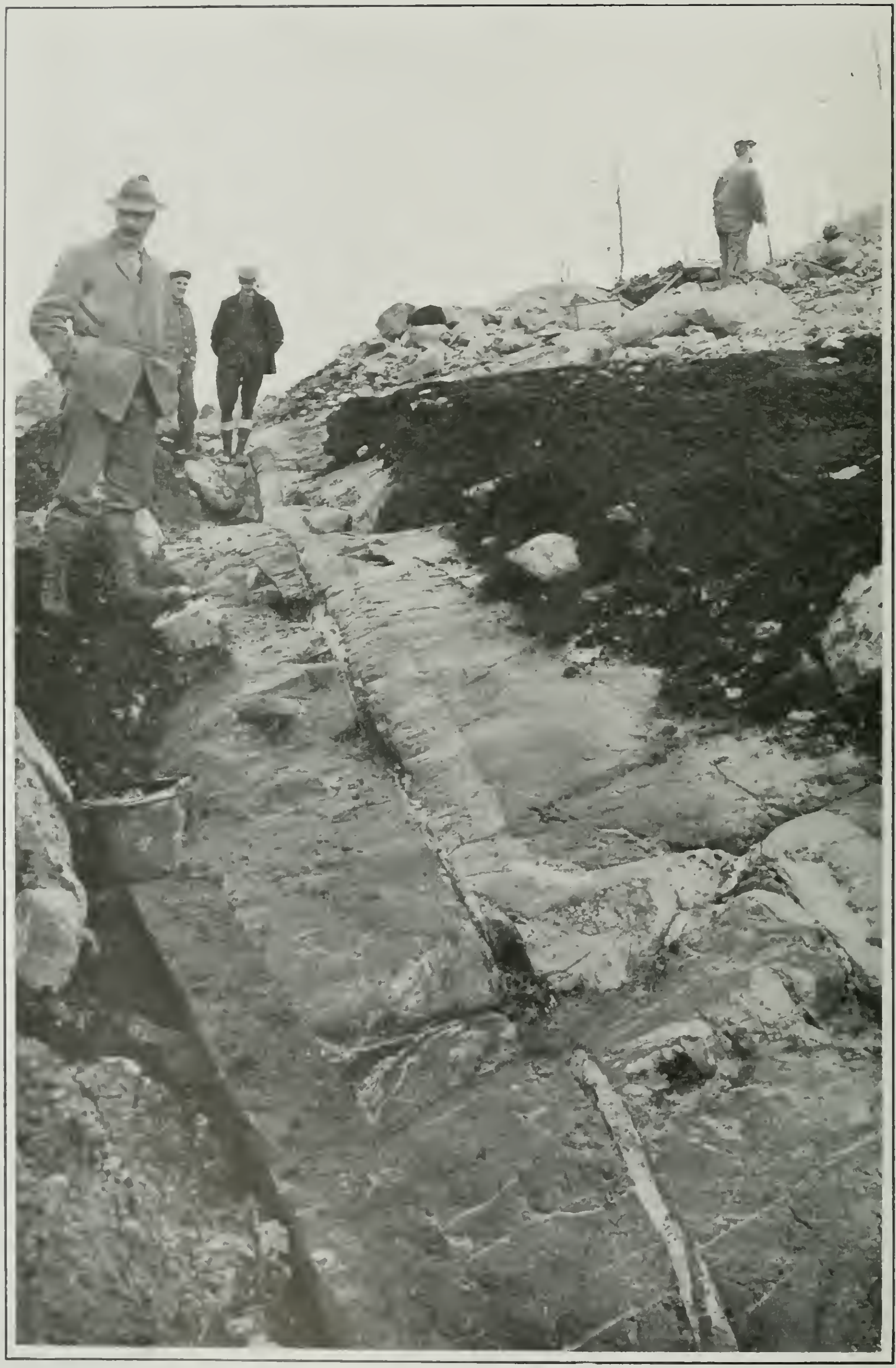

Photo by A. A. Cole

Cobalt-Silver vein uncovered in pumping out Kerr Lake

STATISTICAL REVIEW

of the

MINERAL INDUSTRY OF ONTARIO FOR 1913

By Thos. W. Gibson, Deputy Minister of Mines

Diversity of occupation exercises a favorable influence upon the development of a new country. No one industry, of course, is self-sufficient, and, in these days of increasing specialization, every industry tends to become more dependent upon and more necessary to all the others.

Naturally, the industries which first take root in a given area are those for which its resources are most evidently adapted. In a wooded country, such as northern Ontario, the first in order of time is lumbering. Where the land is good and railway access is afforded, agriculture comes at once upon its heels, closely followed, where there are workable minerals, by mining. Soon all three industries are found in various stages of development, each playing an important part in the settlement of the country. Felling the trees and hauling the logs give employment to the settler during the winter months and help him to earn some ready money. Lumberjacks and miners alike must be fed, and so there is a home market for all the farm produce which the settlers can raise beyond their own requirements. The settler is himself a lumberer so far as his own farm is concerned, and brings sawlogs, pulpwood, railway ties and fence posts to market. Buildings must be put up at farm and mine, and for these lumber is necessary.

Most of the lumberman's cut of sawlogs or the output of his sawmill is transported elsewhere to find a market, and this is the case also with the silver, gold, copper or nickel won from the mine. But in the production and handling of these commodities much labour and capital are called into use. Communities are formed, and industrial and social development goes on. Water powers, so numerous in northern Ontario, are compelled to furnish power, light and traction. Pulp and paper mills are erected to make use of the abundant supplies of spruce and poplar. Roads and railways are built. Schools, churches, hospitals, and other institutions with improvement and amelioration as their end, come into being. So too, unfortunately, do jails and blind pigs, for crime and excess accompany the human animal whether he is found in forest or mine or the crowded town.

A large proportion of the labour in mine and lumber shanty, and in railway and wagon road-making, is of the unskilled type, where muscle counts for more than mind. Very much of this is supplied by immigrants from foreign lands—chiefly those of continental Europe—and hence a surprisingly large share of the industrial population of the north is composed of Finns, Poles, Austrians, Italians, Bulgarians, etc. There are also Syrians in considerable numbers and Greeks, but they are usually in trade, and are rarely found engaged in manual labour. Whether or not the presence of large numbers of non-English-speaking labourers is wholly desirable, this is perhaps not the place to discuss, but the fact is they are there, and in response to a demand. Mine managers and railway contractors assert, and no doubt with truth, that they could not operate their mines or build their embankments were it not for this foreign labour. Anyone looking over the list of mining accidents in this Report, compiled by Mr. T. F. Sutherland, Chief Inspector of Mines, cannot but be struck with the large percentage of names of foreign origin. Doubtless there is a connection between this fact and the comparatively high death and accident rate in the mines of the Province. In part this may be due to unfamiliarity with the English language and the difficulty of comprehending quickly spoken orders in an emergency. Mental traits have also to be reckoned with, and the fact that very few of these men were miners before coming to this country, or at any rate to this continent. Ignorance of the risks in mining and the handling of explosives, a certain lack of resourcefulness in the presence of danger, amounting almost to inertia or even stupidity, and other characteristics, contribute to the same result. The building up of a strong force of capable and experienced miners such as the mining industry of Ontario now imperatively requires, will be a slow process, but when accomplished it will mean very much for the effective and economical operation of our mines.

The production of minerals in 1913 was again the largest on record, amounting in "spot" value to $53,232,311 as compared with $48,341,612 in 1912—an increase of $4,890,699 or 10 per cent. To show the large advances which the yearly output is now making, the figures for ten and five years ago may be cited. In 1903 the value of the production was $12,870,593, and in 1908 $25,019,373. Thus during the last ten years the mines and mineral works of the Province have increased their output by 313 per cent., and during the last five years by 112 per cent.

Of late years the chief annual gain has been in metals and metalliferous substances, due to the great development which has characterized mining for silver, nickel, copper and gold—in other words, to Cobalt, Sudbury and Porcupine. In 1913 both the metallic and non-metallic branches of the industry shared in the growth; in fact, while the former had a greater absolute advance, the latter showed a higher percentage of gain—15 per cent. as against 7.7 per cent. for the metallic division. In the aggregate, however, the metals bulk much more largely than the non-metals, contributing 70.5 per cent. of the total as compared with 29.5 per cent.

Following is Table I, which gives a summary of the production for the year and also the number of employees and the amount of wages paid in obtaining the various products.

Table I.—Mineral Production of Ontario, 1913

Product.	Quantity.	Value.	Employees.	Wages.
Metallic:		$		$
Gold .... ounces	220,837	4,558,518	1,470	1,571,425
Silver .... "	29,724,931	16,579,094	911	3,613,403
Copper .... tons	12,941	1,840,492	3,512	3,291 956
Nickel .... "	24,838	5,237,477		
Iron ore .... "	195,937	424,072	631	393,258
Pig iron .... "	648,899	8,719,892	1,014	876,484
Cobalt oxide, etc. .... lbs.	(a) 1,188,526	420,386	318	258,817
Nickel do. .... "	(b) 232,255	13,326		
	....	37,793,257	10,856	10,005,343
Less Ontario iron ore (132,708 tons) smelted into pig iron	....	285,322	....	....
Net metallic production	....	37,507,935	....	....
Non-metallic:				
Arsenic, refined .... lbs.	(c) 2,450,758	64,146	(d)	(d)
Brick, common .... No.	408,808,000	3,452,352	3,243	1,433,790
Tile, drain .... "	16,935,000	292,767		
Brick, paving, etc. .... "	18,547,000	243,119	741	461,326
Brick, pressed .... "	81,238,000	919,741		
Stone, building and crushed	....	1,137,153	1,162	596,195
Calcium carbide .... tons	2,052	123,100	38	31,741
Cement, Portland .... bbl.	3,802,321	4,105,455	1,382	955,729
Corundum .... tons	1,177	137,036	61	47,502
Feldspar .... "	18,615	67,142	78	33,317
Graphite, refined .... "	1,788	93,054	87	41,414
Gypsum .... "	40,581	92,627	(e) 140	(e) 81,057
Iron pyrites .... "	71,620	171,687	163	136,069
Lime .... bush.	2,300,991	390,600	277	149,280
Mica .... tons	386	55,264	72	27,950
Natural gas .... million cub. ft.	12,516	2,362,021	402	289,480
Peat .... tons	500	1,750	13	1,000
Petroleum .... Imp. gal.	7,915,761	398,051	(f) 781	(f) 559,557
Pottery	....	52,875	38	21,751
Quartz .... tons	54,320	130,860	90	57,501
Salt .... "	96,799	474,372	234	172,691
Sewer pipe	....	600,297	245	160,903
Sand and Gravel .... cub. yd.	425,978	233,567	162	77,475
Talc, ground .... tons	20,738	125,340	50	37,369
Non-metallic production	....	15,724,376	9,459	5,373,097
Add metallic production	....	37,507,935	10,856	10,005,343
Totals	....	53,232,311	20,315	15,378,440

(a) The estimated quantity of metallic cobalt contained in the ores raised from the silver-cobalt mines was 377 tons; this includes the quantity converted into oxide.

(b) The estimated quantity of metallic nickel contained in the silver-cobalt ores was 821 tons, which is included in the quantity converted into oxide.

(c) The ores extracted from the Cobalt silver mines are estimated to have contained 3,633 tons of arsenic, which includes the quantity of refined arsenic given in the table.

(d) Included in cobalt and nickel oxide. (e) Including alabastine works. (f) Refining works.

Table II, given below, makes a comparison between the production of 1913 with that of 1912.

The greatest increase and the greatest decrease are both found among the metals. Gold shows the largest gain, $2,444,432 (106.1 per cent.), and silver the largest falling off, $1,092,824 (6.1 per cent.). Other gains in the metallic list are: copper, $256,182, or 16.1 per cent.; nickel, $501,017, or 10.5 per cent.; pig iron, $665,523, or 8.2 per cent. No production of platinum, palladium or lead was reported for 1913.

Among the twenty-four non-metallic products, twenty show gains, and four losses, as compared with 1912. The largest advance is in Portland cement, $739,796 (21.9 per cent.); other noticeable increases are in pressed brick ($285,572, or 45 per cent.), common brick ($274,102, or 8.6 per cent.), iron pyrites ($100,644, or 141 per cent.). Notwithstanding the decrease in the production, the value of petroleum was greater by $53,514 or 15.5 per cent. Sewer pipe is up by $135,670 or 29.1 per cent., talc by $63,982 or 104.2 per cent., gypsum by $42,381 or 84.3 per cent., and building and crushed stone by $183,314, or 19.4 per cent.

Decreases occur in arsenic ($15,151 or 19.1 per cent.), corundum ($96,176 or 41.2 per cent.) and quartz ($48,716 or 27.1 per cent.). There was also a small decrease in mica.

Table II.—Comparative Value Mineral Production, 1912 and 1913

Product.	1912	1913	(I) Increase. (D) Decrease.	
Metallic:	$	$		$
Gold	2,114,086	4,558,518	I	2,444,432
Silver	17,671,918	16,579,094	D	1,092,824
Copper	1,584,310	1,840,492	I	256,182
Nickel	4,736,460	5,237,477	I	501,017
Iron ore	238,884	424,072	I	185,188
Pig iron	8,054,369	8,719,892	I	665,523
Cobalt	315,781	420,386	I	104,605
Nickel oxide		13,326	I	13,326
Platinum	80,736		D	80,736
Palladium	147,235		D	147,235
Lead	1,290		D	1,290
Non-metallic:				
Arsenic	79,297	64,146	D	15,151
Brick, common	3,178,250	3,452,352	I	274,102
" paving, fancy, etc	221,986	243,119	I	21,133
" pressed	634,169	919,741	I	285,572
Stone, building and crushed	953,839	1,137,153	I	183,314
Calcium carbide	120,000	123,100	I	3,100
Cement, Portland	3,365,659	4,105,455	I	739,796
Corundum	233,212	137,036	D	96,176
Feldspar	28,916	67,142	I	38,226
Graphite	65,076	93,054	I	27,978
Gypsum	50,246	92,627	I	42,381
Iron pyrites	71,043	171,687	I	100,644
Lime	281,672	390,600	I	8,928
Mica	57,384	55,264	D	2,120
Natural gas	2,268,022	2,362,021	I	93,999
Peat	725	1,750	I	1,025
Petroleum	344,537	398,051	I	53,514
Pottery	52,445	52,875	I	430
Quartz	179,576	130,680	D	48,716
Sand and Gravel		233,567	I	233,567
Salt	450,251	474,372	I	24,121
Sewer pipe	464,627	600,297	I	135,670
Talc	61,358	125,340	I	63,982
Tile, drain	279,579	292,767	I	13,188

Table III gives the value of the mineral production for each of the last five years, and a glance at the figures shows the steady advance which has been made during that period. The increase from 1909 to 1913 is $20,250,936, of which the metallic division furnished $14,579,439 and the non-metallic division $5,671,497. The gain in the former was 63.5 per cent. and in the latter 56.4 per cent.

Table III.—Mineral Production, 1909 to 1913

Product.	1909	1910	1911	1912	1913
Metallic:	$	$	$	$	$
Gold	32,445	68,498	42,637	2,114,086	4,558,518
Silver	12,464,722	15,481,322	15,953,895	17,671,918	16,579,094
Cobalt	94,965	54,699	170,890	315,781	120,386
Copper	1,127,015	1,374,103	1,281,118	1,584,310	1,840,492
Nickel	2,790,798	4,005,961	3,664,474	4,736,460	5,250,803
Iron ore	645,622	513,721	445,930	238,884	424,072
Pig iron	6,301,528	6,975,418	7,716,314	8,054,369	8,719,892
Zinc ore	8,950	5,760	....	....	....
Lead	....	....	....	1,290	....
Platinum	....	....	....	80,736	....
Palladium	....	....	....	147,235	....
	23,466,045	28,479,482	29,275,258	34,945,069	37,793,257
Less value Ontario iron ore smelted into pig iron	537,549	317,804	172,391	145,326	285,322
Net metallic production	22,928,496	28,161,678	29,102,867	34,799,743	37,507,935
Non-metallic:					
Actinolite	....	320	....	....	....
Arsenic	61,039	70,709	74,609	79,297	64,146
Brick, common	1,916,147	2,374,287	2,801,971	3,178,250	3,452,352
" paving	73,700	70,648	86,685	221,986	243,119
" pressed	490,571	458,596	564,630	634,169	919,741
Building and crushed stone	660,000	761,126	892,627	953,839	1,137,153
Calcium carbide	151,676	184,323	81,437	120,000	123,100
Cement, Portland	2,897,348	3,144,343	3,640,642	3,565,659	4,105,455
Corundum	140,817	171,994	147,158	233,212	137,036
Feldspar	36,204	47,518	51,610	28,916	67,142
Fluorspar	....	15	200	....	....
Graphite	37,624	55,637	36,492	65,076	93,054
Gypsum	23,604	17,825	32,535	50,246	92,627
Iron pyrites	78,170	98,353	118,457	71,043	171,687
Lime	470,858	474,531	402,340	381,672	390,600
Mica	73,124	85,294	43,058	57,384	55,264
Natural gas	1,188,179	1,491,239	2,186,762	2,268,022	2,362,021
Peat fuel	240	1,284	2,830	725	1,750
Petroleum (crude)	559,478	368,153	353,573	344,537	398,051
Phosphate of lime	1,904	....	240	....	....
Pottery	43,214	51,185	50,500	52,445	52,875
Quartz	75,329	87,424	64,405	179,576	130,860
Sand and gravel	....	....	....	....	235,567
Salt	389,573	414,978	430,835	450,251	471,372
Sewer pipe	311,830	357,087	410,064	464,627	600,297
Talc	8,700	46,592	47,725	61,358	125,340
Tile, drain	363,550	318,456	349,545	279,579	292,767
Total non-metallic production	10,052,879	11,152,217	12,873,930	13,541,869	15,724,376
Add metallic production	22,928,496	28,161,678	29,102,867	34,799,743	37,507,935
Total production	32,981,375	39,313,895	41,976,797	48,341,612	53,232,311

As nearly as can be determined, the total value of the metals produced in Ontario since mining in the Province began has now reached the sum of $263,486,309. Table IV gives the several items. From this amount should be deducted, for the sake of accuracy, the value of domestic iron ore smelted into pig iron in the Province, which will leave the net total in the neighborhood of $259,000,000. Statistics of the production of platinum, which is not refined in this country, and one or two other metals are incomplete.

Table IV.—Total Production of Metals in Ontario

Product	Value
	$
Gold	9,293,231
Silver	113,755,383
Platinum and Palladium	290,755
Cobalt	1,492,527
Nickel	46,263,566
Copper	19,080,023
Iron Ore	7,148,457
Pig Iron	65,965,993
Lead	117,290
Zinc Ore	92,410

Gold

The yield of gold last year was 220,837 ounces, valued at $4,558,518, which was almost equal to the entire production of the Province from the time the first gold was obtained at Madoc in 1866 down to the end of 1912.

There were 16 mines producing bullion, of which seven were in the Porcupine field, as follows: Hollinger, Dome, Porcupine, Acme, Mines Leasing Company (Rea) and Porphyry Hill. The production of the last three was inconsiderable. Three mines at Kirkland and Swastika lakes yielded gold, namely, Tough-Oakes, Swastika, and Lucky Cross. At Larder lake two mines contributed—La Mine D'Or Huronia and Goldfields Limited. There was one each at the following points: Long lake (Canadian Exploration Company), Sturgeon lake (Northern Reef), Atikokan (Elizabeth) and Hastings county (Cordova).

The lion's share of the output was from Porcupine, which furnished no less than $4,294,113 out of the whole. Here the principal producers were the Hollinger and Dome.

Hollinger Mine

During the 12 months ending 31st December, 1913, the Hollinger mine milled 138,291 tons of ore, the yield from which was $2,466,220.24 or $17.82 per ton. In 1912, 45,195 tons were milled, yielding $933,682.00 or $20.65 per ton. The total quantity of ore treated since the mine began operations therefore was 183,486 tons, from which gold was obtained to the value of $3,399,902.24 or $18.52 per ton. The value of the ore sent to the stamps last year was $2,566,414.59, of which all but $100,436.18 was saved. This represents an extraction of over 96 per cent. There was paid out in dividends in 1913 the sum of $1,170,000, and carried forward to surplus $544,214.36, making the total surplus at 31st December, 1913, $688,462.80, of which $510,000.00 was in cash and quickly convertible assets. From the total cost of the plant, $711,975.10, there was written off during the two years the sum of $211,975.10.

Working costs for the year were as follows per ton of ore milled

General charges	$ .220
Strike expense	.225
Administration and management	.332
Taxes	.060
Insurance	.121
Clearing surface, roads, etc.	.028
Operating camps	.167
Operating boarding-houses	.114
Mining	3.089
Milling	1.753
	6.110

Allowing for a small quantity of ore treated for the Acme mine, and adding the equivalent per ton for depreciation of plant, etc., a total working cost is obtained of $6.975 per ton of ore milled. The operating expenses were considerably enhanced by the miners' strike in the Porcupine camp which began on the 15th November, 1912, and was declared off on 9th June, 1913, the strikers being unsuccessful in resisting a reduction of wages. The capacity of the mill has been increased from 300 to 500 tons of ore per day, and extensions are under way which will further increase the capacity to 650 tons per 24 hours. It is the view of the management that with the increased output the total cost of production and treatment can be gradually decreased to about $4.50 per ton. During the year $105,751.56 was expended on buildings and equipment.

Ore was hoisted from the levels at 100, 200, 300 and 425 feet, and a small quantity from below 425 feet. From vein No. 1 there were drawn 70,506 tons, from No. 2, 24,022 tons, and from No. 4, 31,828 tons. The mining work for the year comprised 4,149 feet of drifting at the second levels, 948 feet of cross-cuts, 334 feet of raises, 212 feet of winzes, 368 feet of shaft-sinking, 2,651 feet of diamond-drilling, and 550 feet of trenching.

The ore reserves are placed at 845,300 tons, having a value of $11,604,800, or an average of $13.71 per ton. This is an increase of $1,374,800 as compared with the estimate of a year previous. To No. 1 vein is allotted 284,200 tons, to No. 2 vein 208,400 tons, and to No. 4, 121,100 tons. The average grade of all ore in reserve shown at the beginning of the year was $17.48 per ton. The falling off to $13.71 at 31st December is due principally to the fact that the greater part of the year's development was done upon veins of comparatively low value. In average contents the veins in reserve vary from $7.47 for No. 3 to $19.56 for No. 1, and $20.00 for No. 4.

The capital stock of Hollinger Gold Mines, Limited, is $3,000,000, divided into 600,000 shares of a par value of $5 each. It owns four mining claims of approximately 40 acres each in the township of Tisdale.

Dome Mine

During the year ending 31st March, 1914, there were milled at the Dome mine 145,305 tons of ore, which realized $1,204,597.64, or a net recovery of $8.29 per ton. The following were the expenditures: Operating, $453,965.70; Development, $161,547.76; Plant and Equipment, $303,999.02; total, $919,512.48, leaving a balance of $287,779.99.

The operating cost, excluding all development charges, was $3.08 per ton, which represents a decrease as compared with 1912 of $1.49 per ton. This improvement is attributed to the use of hydro-electric power during most of the year, the larger tonnage milled, increased efficiency of methods and a better supply of labour.

A large amount of development work was done, mostly at No. 2 shaft section, in opening up the third, fourth and fifth levels, east of the "Dome" outcrop, and in further shaft sinking. On the third level a large body of ore was disclosed equivalent to a horizontal area of 100,000 square feet, and defined by 859 feet of drifts and

969 feet of cross-cuts. The average value of this body is estimated at $3.49 per ton. Immediately below, on the fourth and fifth levels, further areas of ore were located, averaging at the former a value of $4.03 per ton and at the latter $4.94 per ton. The amount of development work done figured on the ore milled was equal to $1.11 per ton.

The balance of fully developed lower grade ore above the 100-foot level is given as 512,600 tons of an average value of $4.84 per ton, and, in addition, the development work in No. 2 shaft section indicated the existence of 2,000,000 tons of ore, averaging $3.50 per ton. Diamond drilling has shown other low grade ore bodies to exist, but the data obtained are not sufficiently definite to warrant an estimate of tonnage or values.

The ore sent to the mill came very largely from surface pits, the mine having so far been worked mainly as a quarry, quartz and schist alike being crushed. The total value of the ore treated was $1,274,598.29, or an average of $8.77 per ton. The percentage of recovery was 94.51. The bullion obtained by amalgamation amounted in value to $730,866.79, and by cyanidation $473,730.85.

In June, 1913, it was decided to increase the capacity to 340,000 tons of ore per year by the addition of 40 stamps, making 80 stamps in all, and to change the process from an all-slime to a combined sand-leaching and slime treatment. Briefly the operations of the enlarged mill may be thus described: The ore, after being delivered from the rock breaker station, will be crushed by 80 stamps and 5 tube mills, the product from the latter being distributed over 24 amalgamating plates, from which one-half the gold will be recovered. The product will then be classified into sands and slimes by means of hydraulic classifying and concentrating cones. The sands will be delivered to six tanks, each 40 feet in diameter by 8 feet 6 inches deep, the extraction of gold from the sands being by means of the leaching of cyanide solution The slimes will be treated in the existing plant of Pachuca tanks and Merrill slime presses. When the new plant is fully in operation, it is expected to have a favorable influence on working costs, reducing the latter to at least $2.50 per ton of ore.

The above particulars are in the main abstracted from the company's third annual report. Referring to the mine, the report characterizes it as "a deposit of low grade ore which should be worked by a policy of non-selective mining, and which, on the new basis of treatment, gives assurance of a profitable life."

Porcupine Crown

This property, a controlling interest in which is owned by the Crown Reserve Mining Company, Limited, is obtaining satisfactory results. It is situated to the south of and adjoining the Hollinger mine. Five levels were in operation at the close of 1913, at 100, 200, 300, 400 and 500 feet respectively. The mill, which was enlarged during the year from 5 to 15 stamps, treated 19,715 tons of ore of an average value of $20.30 per ton, the recovery of gold amounting to $325,542.50.

At the beginning of the year the mill was of 5 stamps only, but 15 stamps were added and the continuous decantation process of cyaniding introduced, increasing the percentage of recovery from 85 to 96 per cent. The reserves of ore are estimated at 72,472 tons, worth $1,860,227.95, or an average of $25.66 per ton. The ore shoot is proven to have a length of 600 feet, and diamond drilling has located either a continuation of one ore body, or an altogether new one. In estimating the ore reserves, no allowance is made for any depth below that actually proved by the working faces, nor for any lateral length beyond such proven places. The company expects to treat 35,000 tons of ore during 1914, and is confident of making a profit of $25,000 per month. As it is without debt, it decided to begin paying a dividend at the rate of 12 per cent. per annum from 1st January, 1914. The Company's capital is $2,000,000, the par value of the shares being $1 each.

Kirkland Lake

The rich, if small, veins of gold ore found at Kirkland lake brought that field well into view during 1913. The lake itself is about five miles northeast of Swastika station, on the Timiskaming and Northern Ontario Railway, and really lies within the Swastika gold area to the south. The geological characteristics of these areas are described in part two of this report.

The principal property, or at any rate the one upon which the largest amount of development work has been done, is the Tough-Oakes, a group of five claims of about 40 acres each. By the end of the year the shaft was down to 208 feet, and there were two levels, at 100 and 200 feet respectively. Some 247 feet of drifting had been done on the 100-foot level and 146 feet on the 200-foot level. From the narrow veins two shipments of hand-picked ore were made in 1912, and three in 1913, to smelters in Pennsylvania and New Jersey. These shipments comprised in all 101.04 tons of ore, which gave the remarkable return of $46,221, or $457.00 per ton. The silver contents ran from 23 to 64 ounces per ton. In addition, 1,975 tons of lower grade ore was put through a 5-stamp mill on the property, from which $26,232.31 in gold was recovered, or $13.28 per ton, in addition to $116.56 worth of silver.

Other groups of claims are known as the Teck-Hughes, Sylvanite, Burnside, Gull Lake, Wright-Hargrave, etc. On the Teck-Hughes in January, 1914, there were three shafts, No. 1 being 120 feet deep, No. 2, 48 feet and No. 3, 80 feet. Nos. 1 and 3 were in the porphyry, No. 2 in the conglomerate. There were 200 feet of drifting and cross-cutting at 100 feet in shaft No. 1, and 205 feet of drifting and cross-cutting in No. 3 at 75 feet.

The Kirkland Lake Proprietary, Limited, formed in London, England, has acquired control of the Tough-Oakes and Teck-Hughes groups, and there was considerable exploitation of the London share market, where stock manipulation is thoroughly understood. The area is certainly a promising one, and if it receives fair treatment from company promoters, its merits will ere long be demonstrated. The veins are found in Timiskaming conglomerate and greywacke in contact with porphyry, and also in the latter. Water power at Long lake on the Blanche river is being developed, and electric current will be transmitted to Kirkland lake for the operation of the mines.

The Lucky Cross and Swastika mines each produced a small quantity of bullion. The mill at the former was increased from 5 to 10 stamps. The original 5 stamps ran about a month and a half, and the completed mill about 35 days.

Other Gold Areas

Of the remaining gold mines, the principal producer last year was the Canadian Exploration Company's property at Long lake on the Sault Branch of the Canadian Pacific Railway. This mine, which contains arsenical ore, has been in course of development for some years. The mill now contains 20 stamps, and is equipped with a cyanidation plant. For some time operations were restricted by lack of power, but connection has now been made with the line of the Wahnapitae Power Company. The plant was in operation for nine months of the year.

In the Larder Lake Mining Division, Goldfields, Limited, carried on some more or less desultory work. The company has developed a water power at Raven falls for the operation of its mine and works. La Mine D'or Huronia, a Three Rivers (Que.) company, have developed a mine near Beaverhouse lake, and have turned out some bullion. It is proposed to operate the mine by a water power on Victoria creek, a short distance away.

At Sturgeon lake, the Northern Reef, or St. Anthony mine, maintains an intermittent existence. It was operated for part of the year only.

In the county of Peterborough, the Cordova mine produced some gold, but was closed down in August. It was reported early in 1914 that new capital had been obtained and that the property was to be re-opened. No other mine in Eastern Ontario reported any production of gold during the year.

The Elizabeth mine, situated 4½ miles west of Atikokan station on the Canadian Northern Railway, ran a few tons of ore through its mill of 10 stamps. More or less development work was done here, and also at the Canadian Homestake, six miles from Kenora, formerly known as the Scramble mine. The shaft at the latter property was down 200 feet at the close of the year. The mine has an electrical equipment throughout, and derives its power from Kenora.

Gold Mining Companies

The gold mining companies reporting to the Bureau for last year are given in the following list, which shows the number of stamps in the several mills, and which were producing and which non-producing concerns:—

Gold Mining Companies, 1913

Name of Company.	Name of Mine.	Locality.	No. of Stamps.	P. O. Address of Manager, etc.
Producing Companies:—				
*Acme Gold Mines, Limited.	Acme	Porcupine		Timmins.
Canadian Exploration Company, Limited.	Long Lake	Long Lake	20	Naughton.
Cordova Mines, Limited	Cordova	Peterboro' county	30	Cordova.
Elizabeth Gold Mines, Limited	Elizabeth	Atikokan	10	Atikokan.
†F. C. Preston & W. C. Offer	Porphyry Hill.	Porcupine		South Porcupine.
Goldfields, Limited	Goldfields	Larder Lake	30	Larder Lake.
Hollinger Gold Mines, Limited	Hollinger	Porcupine	40	Timmins.
La Mine D'Or Huronia, Limited	Huronia	Larder Lake	10	Larder Lake.
Lucky Cross Mines of Swastika, Limited.	Lucky Cross.	Swastika	10	Swastika.
McIntyre-Porcupine Mines, Limited	McIntyre-Porcupine	Porcupine	10	Schumacher.
Northern Gold Reef, Limited	St. Anthony	Sturgeon Lake	10	Toronto.
Porcupine Crown Mines, Limited	Porcupine-Crown	Porcupine	20	Timmins.
Mines Leasing & Development Company, Limited	Rea	Porcupine	5	Schumacher.
The Dome Mines, Limited	Dome	Porcupine	40	South Porcupine.
The Swastika Mining Company, Limited.	Swastika	Swastika	5	Confederation Life Building, Toronto.
Tough-Oakes Gold Mines, Limited	Tough-Oakes	Kirkland Lake	5	Swastika.
Total			245	
Non-producing Companies:—				
Canadian Homestake Gold Mining Company, Limited	Canadian Homestake	Kenora	..	Kenora.
Dome Lake Mining & Milling Company, Limited	Dome Lake	Porcupine	..	Schumacher.
Jupiter Mines, Limited	Jupiter	Porcupine	..	Schumacher.
Olympia Gold Mining Company, Limited.	Olympia	Shoal Lake	..	92 Reamy Street, St. Paul, Minn.
Pearl Lake Gold Mines, Limited	Pearl Lake	Porcupine	..	Schumacher.
Plenaurum Mines, Limited	Plenaurum	Porcupine	..	Schumacher.
Teck-Hughes Gold Mines, Limited	Teck-Hughes	Kirkland Lake	..	Swastika.
The Gilmour Mining Company, Limited.	Gilmour	Hastings county	5	Gilmour.
Three Nations Gold Mining Company	Three Nations.	Porcupine	10	Porcupine.
Vipond Porcupine Mines Company, Limited	Vipond	Porcupine	..	Schumacher.

* Ore treated in Hollinger mill.

† Four tons ore treated in arrastra; 21 tons shipped to smelter at Perth Amboy, N.J.

Silver

The mines at Cobalt occupy the same position of supremacy in relation to the output of silver in Ontario as do the Sudbury mines to the production of nickel and copper, and the Porcupine mines to the yield of gold. Ten years have now elapsed since the veins at Cobalt began to be worked, and during these ten years 185 and a half million ounces of silver have been produced, valued at 98 and a quarter million dollars. This means that the total weight of pure silver yielded by the mines up to 31st December, 1913, was 6,360 tons of 2,000 pounds each; or in other words, allowing 313 working days to a year, 2 tons of pure silver have been taken out of the mines of Cobalt for every working day since they began to produce.

The production for 1913 was 29,681,975 ounces, which is 561,884 ounces less than in 1912, or a decrease of 1.85 per cent. This falling off is in itself not a serious matter, but last year was the second year in succession to show a diminution as compared with its predecessor, and it may now be concluded that the climax of production has been passed, and that henceforth a smaller yield may year by year be looked for. High-water mark was reached in 1911, when the output was 31,507,791 ounces. Compared with the yield of 1911, that for 1913 shows a diminution of 5.79 per cent. To obtain the total production of silver in the Province, it is necessary to add to the quantity above given the silver accompanying the bullion obtained from the gold mines. This amounted to 42,956 ounces, making the entire yield of silver 29,724,931 ounces.

The mines of Cobalt proper of course furnish the great bulk of the output, the lesser Cobalts so far not having been relatively important contributors. Apportioning to each source its share of the product, the following figures show the origin of the silver:—

	Ounces.
Cobalt proper	28,195,505
Casey township	825,108
Gowganda	502,370
South Lorrain	248,992
Gold mines	42,956
Total	29,724,931

The number of producing mines in 1913 was 35, as against 34 in 1912. The following list gives the names of those whose production exceeded 1,000,000 ounces:—

Nipissing	4,844,169
Coniagas	3,252,566
La Rose	2,592,775
Cobalt Townsite	2,314,602
McKinley-Darragh-Savage	2,228,497
Kerr Lake	2,072,407
Crown Reserve	1,776,678
Buffalo	1,752,199
O'Brien	1,240,931
Seneca-Superior	1,124,577

The only new name on this list is that of Seneca-Superior, which takes the place of Cobalt Lake. There are, however, some changes in the order of precedence as compared with 1912, when the list contained eleven names. The three leaders in 1912 were again at the head last year, and in the same order, but Cobalt Townsite moved up to fourth place, Crown Reserve dropped from fourth place to seventh, and O'Brien, which was eleventh in 1912, became ninth in 1913.

The following mines yielded less than a million, but more than half a million ounces:—

Cobalt Lake	980,858
Casey-Cobalt	825,108
Timiskaming	768,939
Beaver Consolidated	726,801
Trethewey	599,036
Hudson Bay	544,823

The other producing mines were Aladdin Cobalt, Bailey Cobalt, Chambers-Ferland, City of Cobalt, Cobalt Comet, Cochrane, Colonial, Drummond, Hargrave, Lumsden, Orion Realty, Penn-Canadian, Gould, Right-of-Way, Silver Bar, York-Ontario, Mann, Miller Lake-O'Brien, Wettlaufer-Lorrain.

In the outlying camps the productive mines were:—In Casey township, Casey-Cobalt; in Gowganda, Miller Lake-O'Brien and Mann; in South Lorrain, Wettlaufer-Lorrain.

Shipments

There were shipped from the Cobalt district last year 9,861 tons of ore and 11,016 tons of concentrates, a total tonnage of 20,877. The shipments in 1912 comprised 10,719 tons of ore and 11,214 tons of concentrates, total 21,933 tons. As has been pointed out on previous occasions, the natural evolution of camp practice is in the direction of carrying the treatment of ore to the highest profitable point. Thus, the Nipissing Company, which has led the way in ore processes at Cobalt, by means of its high grade and low grade ore mills, brings practically all the product of its mines to the form of merchantable bars, which are shipped direct to London. It purchases considerable quantities of ore from other mines, and ships the result also as refined bars. The total production of bullion in the Nipissing mills was 6,530,871 ounces, of which 4,726,994 ounces were the product of Nipissing ores, and 1,803,877 ounces the product of ore received from other mines. Similarly, the Buffalo mine, which has also a mill for treating high grade ore and concentrates, sent almost the entire output of its mine to market in the form of bullion. The total product of the Buffalo last year was 1,752,199 ounces, of which only 83,436 ounces were marketed in concentrates, the remainder, 1,668,763 ounces, being converted into bullion. One result of the tendency above noted is of course to restrict bulk shipments of untreated material. The reduction works connected with the Coniagas and O'Brien mines, though situated at Thorold and Deloro respectively, are really part of the equipment of Cobalt camp, and were they located within its limits the consignments by railway would be still further curtailed, since they treat a large part of the high grade output both as ore and concentrates.

The silver contents of the shipments were as follows:—

Product.	Quantity. (tons)	Silver. (ounces)
Ore	9,861	13,668,079
Concentrates	11,016	8,489,321
Bullion	.....	7,524,575

Concentration of Ore

The remarkably rich ore which characterized the Cobalt deposits when they were opened and during the early stages of their operation, is by no means as yet exhausted. Old veins continue to be worked, and new ones are found from time to time both on the surface and by exploration underground. Notable instances of recent date were the rich vein found by the Seneca-Superior Company while prospecting their ground under the bed of Cart Lake, leased from the Peterson Lake Company, and the spectacular outcrops disclosed on the Kerr Lake property on draining the lake.

Notwithstanding this persistence of high grade ore, it is being recognized that the future of the camp depends largely upon the lower grades of material. These are principally of two kinds. One is composed of small stringers of ore of ordinary type, occurring in sufficient abundance in a given area to render the whole workable. The other is wall rock, into the cracks and fissures of which native silver in thin films and plates has passed from the main veins.

Concentration of low grade ore is now part of the established practice at Cobalt, and practically all the mines of importance either have concentrating plants of their own or arrange with one or other of the custom works at Cobalt for treatment of their low grade. The latter practice is not confined to the poorer classes of ore. The Nipissing high grade mill treated 632 tons of high grade ore last year from some half dozen mines which found it more convenient or profitable to dispose of their ore in this way than to ship it out of the camp.

The quantity of low grade ore concentrated during the year was 470,377 tons, the resulting concentrates weighing 11,268 tons, the average ratio of concentration being therefore 42.5 to 1. This quantity does not include the material treated in the Nipissing and Buffalo low grade mills or the Dominion Reduction Works, where the concentrate product was converted into bullion, but comprises only the ores treated at the various mines and works, the product of which was shipped out of the camp as concentrates to be treated elsewhere The actual shipments of concentrates amounted to 11,016 tons, containing 8,489,321 ounces of silver, an average of 770.6 ounces per ton. Applying this average to the whole production, it would appear that the silver content of the 11,268 tons would be 8,683,120 ounces.

The low grade ores refined into silver bullion at the Nipissing, Buffalo and Dominion Reduction Company's works, amounted to 204,151 tons, yielding 5,127,043 ounces of silver, an average of 25.1 ounces per ton.

A complete statement of the low grade ores manipulated in the various concentrating and refining plants of the Cobalt camp last year would therefore be as follows:—

	Ore treated. (tons)	Product. (tons concentrates)	Silver. (ounces)
At mines and custom works ..	470,377	11,268	8,683,120
Refining works, Cobalt	204,151	Bullion.	5,127,043
Total	674,528	......	13,810,163

The average recovery per ton of ore treated by the mines and custom works was 18.45 ounces, and by the bullion plants 25.11 ounces, or for the whole quantity treated, 20.47 ounces. If it is assumed that as much as 85 per cent. of the original silver was recovered, which is perhaps an over-estimate, the silver contained in the rock when it went to the mills amounted to 16,011,956 ounces, or an average per ton of 24.08 ounces.

The above of course takes no account of the low grade ore shipped to smelters in the United States where, because of its silicious qualities, it is found useful for making furnace mixtures with basic ores. The figures, however, make quite evident the very important part in the Cobalt silver mines which the low grade ores and milling rock have already come to play. It is likely that this importance will increase, rather than diminish, with the progress of the camp.

One effect, already quite noticeable, will be the rise in the demand for labour in proportion to the output of silver. It requires a much larger number of men to get out large quantities of low grade ore than comparatively small quantities of high grade material, and a larger number of hands to treat and manipulate the ores. More machinery and more power are also necessary, involving the expenditure of more capital in fixed investments.

Silver Smelters

The principal smelting works in operation during the year were those of the Nipissing Mining Company, the Buffalo Mines, Limited, the Dominion Reduction Company, the Deloro Mining & Reduction Company, and the Coniagas Reduction Company. The first two are situated on the property of the respective companies at Cobalt, and are operated in connection with the mines. At the Nipissing mill is also purchased high grade ore from other mines. The quantity of such material bought by the Nipissing Company last year was 632 tons, averaging 2,854 ounces of silver per ton. All this was converted into bullion along with 1,200 tons of high grade ore from the

Nipissing mine itself, averaging 2,501 ounces per ton. The total quantity of bullion shipped from the plant being 6,530,871 fine ounces, which includes also the product of the low grade mill, namely, 1,985,209 ounces recovered from 77,240 tons.

The Coniagas works are at Thorold, and handle chiefly the high grade ores and concentrates produced at the Coniagas mine. At Deloro in Hastings county, the Deloro Mining & Reduction Company treat the high grade ores and concentrates from the O'Brien mine, and also similar material brought from other mines at Cobalt.

The Canada Smelting & Refining Company's plant, situated at Orillia, was consumed by fire and was in consequence not in operation during the year.

The Metals Chemical Company, Welland, Dominion Refineries, North Bay, and Buffalo and Ontario Smelting & Refining Company, Kingston, all erected plants of limited capacity, but have not as yet taken an important part in the refining of silver or treatment of Cobalt ores. The Dominion Refineries went into liquidation, and the property is now owned by the Standard Smelting & Refining Company.

Markets and Prices

Viewing the world as a whole, both the output and the price of silver were lower in 1913 than in 1912. The estimate of last year's production by the Director of the United States Mint is 212 million ounces, as compared with 224 million ounces in 1912, and 229 million ounces in 1911. The result is arrived at, however, after crediting Canada with a yield of 38,500,000 ounces, which is certainly an excessive estimate, exceeding the true figures by about 5,500,000 ounces. Making this reduction, the world's production would be in the neighborhood of 206 and a half million ounces. The principal falling off was in Mexico, where mining, in common with all other industries, suffered by the internecine strife which prevailed during the year, and still obtains. The yield of silver in that country is given as 68,050,000 ounces, as against 71,250,000 ounces in 1912 and 75,032,400 ounces in 1911. It speaks well for the intrinsic merits of the silver mines of Mexico when the prevalence of what from the outside looks like anarchy is compatible with so comparatively slight a reduction in the output.

The United States increased its yield from 60,339,400 ounces in 1911 to 63,766,000 in 1912, and 67,601,111 ounces in 1913, thus closely approaching the output of Mexico, hitherto the most important producer. The increase is due largely to an enlarged production by the silver-lead mines of Idaho and Colorado and the silver-gold mines of Nevada. The output of Canada as a whole was about a million ounces more than in 1912.

The other principal important sources of silver are Australia and South America, the former of whom shows a reduction as compared with 1912 of 2,900,000 ounces, and the latter 5,280,000 ounces. Other countries, including Spain, Germany, Japan, Central America and Africa share in the decrease, which seems to have been general throughout all the silver-producing communities of the world, except some of the leading silver camps in the United States.

The course of prices for silver in 1913 was not such as to stimulate production, the average price for fine silver in New York being 59.782 cents per ounce, as compared with 60.837 cents in 1912. In January the price rose to 62.9 cents, fell in February to 61.6 cents, and in March to 57.9 cents; advanced in April to 59.5 cents, and in May to 60.4 cents, receding in June to 59 cents, and in July to 58.7. August saw a rise to 59.3 cents, September to 60.6 cents, and October to 60.8 cents. The price fell again in November to 59 cents, and in December to 57.8 cents.

The demand for silver was less active in 1913 than usual.

Exports from London to India amounted to £9,850,000, as compared with £12,390,641, of which about £5,500,000 was taken by the Indian Government for coinage into rupees in anticipation of moving the excellent crops ensured by favorable monsoons. The ineradicable tendency of the Indian speculators to gamble on the rise and fall of the market led to consequences disastrous to a number of the native banks, the principal of which, the Indian Specie Bank, was obliged to close its doors in November. This institution was committed to the purchase of about £3,000,000 of silver in London, but a strong syndicate was formed in the latter place to take over the whole amount, which action had the effect of restoring the market to more normal conditions. The tendency in India, noted in recent years, to favor gold rather than the time-honored silver for hoarding purposes, was more marked than ever last year. Over £9,500,000 worth of 10-ounce gold bars were forwarded from London to India last year, as compared with £8,124,000 in 1912.

China is another important mart for silver, but the large purchases which have for some time been looked for by the government of that country in order to reform the system of currency have not yet been made. Although China is now nominally a republic, the recently-elected President, Yuan Shi Kai, is apparently not disposed to be trammeled by a useless and expensive Parliament, and has consequently dismissed the latter. What effect this will have upon the scheme of financial renovation, or the many other reforms which have been proposed in that country, time alone will show. Stocks of sycee and bar silver in Shanghai were much larger at the close of 1913 than a year before, having a value of £5,785,000, as against £3,347,000.

What the course of prices for silver may be in the near future no one can predict. In view of the slackening of production, especially in Mexico, and of the shrinkage of stocks on hand at the close of the year to unusually small dimensions, it would seem probable that at any rate no further lowering of values is imminent.

In table V subjoined are presented the statistics of the yearly and total output of silver from the Cobalt mines since the beginning of production in 1904.

Table V.—Silver Production, Cobalt Mines, 1904 to 1913

Year.	Producing Mines.	Shipments.			Silver Contents.			Av'ge Silver Contents per Ton.		Value of Silver Shipments.			Total	
		Ore.	Concentrates	Bullion.	Ore.	Concentrates.	Bullion.	Ore.	Concentrates.	Ore.	Concentrates.	Bullion.	Ounces.	Value.
	No.	Tons.	Tons.	oz.	oz.	oz.	oz.	oz.	oz.	$	$	$		$
1904	4	158	......	....	206,875	....	....	1,309	......	111,887	....	....	206,875	111,887
1905	16	2,144	......	....	2,451,356	....	....	1,143	......	1,360,503	....	....	2,451,356	1,360,503
1906	17	5,335	......	....	5,401,766	....	....	1,013	......	3,667,551	....	....	5,401,766	3,667,551
1907	28	14,788	......	....	10,023,311	....	....	677	......	6,155,391	....	....	10,023,311	6,155,391
1908	30	21,487	1,137	....	18,022,480	1,415,395	....	736	1,244	8,468,293	665,085	....	19,437,875	9,133,378
1909	31	27,729	2,948	....	22,436,355	3,461,470	....	809	1,171	10,809,872	1,651,704	....	25,897,825	12,461,576
1910	41	27,437	6,845	980,633	22,581,714	7,082,834	980,633	821	1,030	11,360,489	3,590,098	527,460	30,645,181	15,478,047
1911	34	17,278	9,375	3,132,976	20,318,626	8,056,189	3,132,976	1,176	858	10,250,991	4,017,241	1,685,615	31,507,791	15,953,847
1912	30	10,719	11,214	5,080,127	15,395,501	9,768,228	5,080,127	1,436	871	8,766,871	5,556,919	3,085,145	30,243,856	17,408,935
1913	35	9,861	11,016	7,524,575	13,668,079	8,489,321	7,524,575	1,386	770	7,444,995	4,554,797	4,554,189	29,681,975	16,553,981
Tl..	..	139,936	42,535	16,718,311	130,506,063	38,273,437	16,718,311	932	901	68,396,843	20,035,844	9,852,409	185,497,811	98,285,096

The Subsidiary Constituents

Since the operators of the silver mines at Cobalt get little or nothing for the cobalt, nickel and arsenic contained in the ores or concentrates which they sell to the smelting companies, practically no record is kept of the quantities produced of these substances.

On the basis of the data set out in the Twentieth Report of the Bureau, pages 17 and 18, it is assumed that the ores and concentrates as shipped from Cobalt contain on the average 3.20 per cent. of cobalt, 1.47 per cent. of nickel, and 14.28 per cent of arsenic. Figuring in the concentrate equivalent of the low grade ores refined to the bullion stage at Cobalt, together with the actual consignments of ore and concentrates, a theoretical production is obtained for 1913 of 821 tons of cobalt, 377 tons of nickel, and 3,663 tons of arsenic. Statistics are obtained from the refining companies which account for the quantities of these several substances recovered in treating the ores and concentrates passed through their plants, but no such information can be had with respect to the consignments of ore and concentrates exported to other countries. In consequence, it is impossible to say what proportion of the cobalt, nickel and arsenic contained in the year's production of ore from the mines of Cobalt eventually finds utilization in the arts, though it is doubtless considerable.

Under these circumstances, in compiling the tables of production, the estimated quantities of these substances are given, and in the valuation column the amount of money actually received by the mine operators and refiners—chiefly the latter—when the products are marketed. For this reason it would be misleading to divide the value by the quantity of any one of these products and to assume that the result would be the average price at which the whole was sold. As a matter of fact, probably a considerable percentage may not have been sold at all, the amount of money shown in the value column simply representing the return obtained for that portion actually sold. It seems desirable, however, to make the record as complete as possible, so that an idea may be obtained not only of the gross value of the output of the Cobalt mines, but also of the potentialities of these valuable elements produced in such profusion and as yet only in part utilized.

Table VI, which follows, gives the gross production of the various metals at Cobalt since the opening of the mines.

Table VI.—Total Production, Cobalt Mines, 1904 to 1913

Year.	Nickel.		Cobalt.		Arsenic.		Silver.		Total Value.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Ounces.	Value.	
		$		$		$		$	$
1904....	14	3,467	16	19,960	72	903	206,875	111,887	136,217
1905....	75	10,000	118	100,000	549	2,693	2,451,356	1,360,503	1,473,196
1906....	160	....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
1907....	370	1,174	739	104,426	2,958	40,104	10,023,311	6,155,391	6,301,095
1908....	612	....	1,224	111,118	3,672	40,373	19,437,875	9,133,378	9,284,869
1909....	766	....	1,533	94,965	4,294	61,039	25,897,825	12,461,576	12,617,580
1910....	504	....	1,098	54,699	4,897	70,709	30,645,181	15,478,047	15,603,455
1911....	392	....	852	170,890	3,806	74,609	31,507,791	15,953,847	16,199,346
1912....	429	14,220	934	314,381	4,166	80,546	30,243,859	17,408,935	17,818,082
1913....	377	13,326	821	420,386	3,663	64,146	29,681,975	16,553,981	17,051,839
Total.	3,700	42,187	7,656	1,471,529	29,517	450,980	185,497,814	98,285,096	100,249,792

Profits and Dividends

From table VII, it will be seen that the amount of the dividends declared by the Cobalt silver mines in 1913 was $9,104,984. This is somewhat less than the amount in 1912, which was $9,324,049. The total dividends declared by these mines to the end of 1913 amount to $50,362,130. Table VI shows that the total value of the output of these mines since the beginning of operations in 1904 to the end of 1913 amounted to $100,249,792. Hence the dividends have been equal to over 50 per cent. of the total output. In addition to dividends declared and paid, profits made by private owners amount to about five million dollars.

The dividends paid by Porcupine gold mines increased from $270,000 in 1912, to $1,170,000 in 1913.

Table VII—Statement of Dividends and Bonuses Declared to December 31st, 1913,

By Cobalt Silver Mines and Porcupine Gold Mines.

Name of Company.	Date of Incorporation.	Authorized Capital.	Capital Stock issued.	Par value per share.	Amount of Dividends and Bonuses declared to end of 1912.	Amount of Dividends and Bonuses declared during 1913.	Total of Dividends and Bonuses declared to Dec. 31, 1913.	Last Dividend or Bonus	
								Date declared.	Rate per cent.
		$	$	$	$ c.	$ c.	$ c.		
Beaver Consolidated Mines, Limited	Feb. 25, 1907	2,000,000	2,000,000	1.00	350,000 00	60,000 00	410,000 00	Nov. 29, 1913	3
Buffalo Mines, Limited	April 27, 1906	1,000,000	1,000,000	1.00	1,877,000 00	810,000 00	2,687,000 00	Dec. 6, 1913	18
Casey Cobalt Mining Company, Limited	Dec. 19, 1908	100,000	100,000		....	199,189 73	199,189 73	Oct. 8, 1913	[illegible]
City of Cobalt Mining Company, Limited	Oct. 5, 1906 Jan. 7, 1909	500,000 1,500,000		1.00 1.00	115,000 00	....	115,000 00	April 15, 1909	3
Cobalt Central Mines Company	Dec. 13, 1906	5,000,000	5,000,000	1.00	192,845 00	....	192,845 00	Aug. 25, 1909	1
Cobalt Comet Mines, Limited	Apr. 16, 1913	1,000,000	1,000,000	5.00	....	27,000 00	27,000 00	Nov. 10, 1913	2.7
Cobalt Lake Mining Company, Limited	Dec. 22, 1906	1,070,834	3,929,166	1.00	75,000 00	40,000 00	115,000 00	Nov. 25, 1913	2½
Cobalt Silver Queen, Limited	April 1, 1906	1,500,000	1,500,000	1.00	315,000 00	....	315,000 00	Dec. 31, 1908	3
Cobalt Townsite Mining Co., Limited	May 6, 1906	100,000	15,011	1.00	441,000 00	371,168 87	812,168 87	Nov. 11 1913	....
Coniagas Mines, Limited	Nov. 24, 1906	1,000,000	4,000,000	5.00	4,280,000 00	1,640,000 00	5,920,000 00	Nov. 1, 1913	14
Crown Reserve Mining Company, Limited	Jan. 16, 1907	2,000,000	1,999,957	1.00	4,775,797 80	795,966 30	5,571,764 10	Dec. 8, 1913	2
Foster Cobalt Mining Company, Limited	Feb. 14, 1906	1,000,000	915,588	1.00	45,000 00	....	45,000 00	Jan. 1, 1907	5
Kerr Lake Mining Company, Limited	Aug. 9, 1905	40,000	40,000	100.00	4,610,000 00	610,000 00	5,220,000 00	Oct. 11, 1913	[illegible]
La Rose Mines, Limited	Feb. 21, 1907	6,000,000	6,000,000	5.00	3,672,516 81	931,000 00	4,603,516 81†	Dec. 12, 1913	[illegible]
McKinley-Darragh-Savage Mines of Cobalt, Limited	April 9, 1906	2,500,000	2,247,692	1.00	3,280,638 58	719,261 44	3,999,900 02	Nov. 11, 1913	[illegible]
Nipissing Mining Company, Limited	Dec. 16, 1904	250,000	250,000	100.00	10,168,297 25	1,830,000 00	11,998,297 25	Dec. 15, 1913	[illegible]
The Right of Way Mines, Limited	Sept. 11, 1909	2,000,000	1,685,500	1.00	202,260 00	....	526,903 93	Dec. 2, 1911	2
Right of Way Mining Company, Limited	July 13, 1906	500,000	500,000	1.00	324,643 93	....			
Seneca Superior Silver Mines Limited	Sept. 29, 1911	500,000	178,881	1.00	....	310,271 60	310,271 60	Nov. 7, 1913	12½
Temiskaming and Hudson Bay Mining Company, Limited	July 29, 1903	25,000	7,761	1.00	*1,707,120 00	162,981 00	1,870,101 00	Dec. 29, 1913	300
The Hudson Bay Mines, Limited	July 16, 1909	3,500,000	3,200,050	5.00	586,906 42	192,003 00	778,909 42	Aug. 31, 1913	2½
Temiskaming Mining Company, Limited	Nov. 16, 1906 Jan. 1, 1908	2,500,000	2,500,000	1.00	1,309,156 25	75,000 00	1,384,156 25	Dec. 31, 1913	3
Trethewey Silver Cobalt Mine, Limited	May 30, 1906 June 1, 1911	1,000,000 2,000,000	1,000,000	1.00	‡ 861,998 50	150,000 00	1,011,998 50	Dec. 1, 1913	5
Wettlaufer-Lorrain Silver Mines, Limited	Nov. 30, 1908	1,500,000	1,416,590	1.00	566,636 00	70,829 50	637,465 50	Sept. 22, 1913	5
Hollinger Gold Mines, Limited	June 28, 1910	3,000,000	3,000,000	5.00	270,000 00	1,170,000 00	1,440,000 00	Dec. 31, 1913	3
Total	....	....	....	....	40,087,146 37	10,271,984 01	50,362,130 41	....	....

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* An error was made in the Dividend return for 1912 the first Dividend for 1913 being included.

† Less profit to original owners.

‡ This amount ($961,998.50) declared in 1913, $861,998.50 paid in that year. The latter figures are those used in the 22nd Report and have been retained here on that account.

In the following notes are given summaries of the annual reports of a few of the most important companies operating in the Cobalt district. The printed reports summarized are those for the calendar year 1913, or the latest company year, as the case may be.

Nipissing

The total production of silver was 4,552,173 ounces, of which about 40 per cent. was from low-grade ore. In addition to this $62,000 was realized from the sale of cobalt residues. Hitherto the percentage derived from high-grade ore was much greater. Total cost of recovery of silver was 24.09c. per oz.; average price received, 60.26c. Total silver production to end of 1913, 32,585,417 ounces.

Coniagas

The figures for this company are for the year ending 31st October, 1913. The rich ore and concentrates from the mill are shipped to the Coniagas Reduction works at Thorold.

The total amount of silver produced was 3,380,846 ounces, about two-thirds of this being from rich shipping ore. The average of the 736 tons of mine ore shipped was 3,057 ounces per ton.

The total production to the end of October, 1913, was 17,662,904 ounces.

Seneca—Superior

This company leased a portion of the holdings of the Peterson Lake Mining Company under Peterson lake. The discovery of a very valuable vein by the Seneca-Superior is one of the most important recent events in the history of the Cobalt district. Substantial production started in the beginning of 1913.

The production for the year was 1,174,000 ounces.

Crown Reserve

The total production for the year was 1,776,676 ounces, of which approximately 65 per cent. was from high-grade ore and 6 per cent. from metallics or bullion contained in the high-grade, the balance being from milling ore shipped to the Dominion Reduction Company.

The total production to end of 1913 was 17,003,821 ounces.

Kerr Lake

For the company year ending 31st August, 1913, the total production was 2,109,975 ounces, of this about 25 per cent. was derived from milling ore treated by the Dominion Reduction Company.

The total cost of production per ounce is given as 21.39 cents.

Cobalt Townsite

The report is for the eleven months ending 30th September, 1913. The total production was 1,987,921 ounces, of this about 21 per cent. was from milling ore and the balance from high-grade.

La Rose

The total production, including that from the Lawson and Princess, for the year was 2,592,775 ounces, of this nearly 75 per cent. was from high-grade ore, the Princess being the heaviest producer. The cost of production was 22.8 cents per oz. The total production to the end of 1913 was 20,420,064 ounces.

McKinley-Darragh Savage

The total silver production for the year was 2,214,036 ounces, about three-quarters of this coming from the McKinley mine. Only about 21 per cent. of the silver from the McKinley is obtained from high-grade ore and nuggets, while with the Savage mine more than half is from this source. The total costs per oz. were 22.33 cents.

The total production to the end of 1913 was 12,863,479 ounces; of this the McKinley has yielded 10,587,513.

Silver Producing Companies, 1913

Name of Company or Owner.	Name of Mine.	Locality.	P. O. Address of Manager, etc.
Aladdin Cobalt Company, Limited	Silver Queen	Cobalt	Cobalt
Bailey Cobalt Mines, Limited	Bailey	Cobalt	Giroux Lake.
Beaver Consolidated Mines, Limited	Beaver	Cobalt	Cobalt
Buffalo Mines, Limited, The	Buffalo	Cobalt	Cobalt.
Casey Cobalt Silver Mining Company, Limited	Casey Cobalt	Casey Township	New Liskeard.
Chambers-Ferland Mining Company, Limited	Chambers-Ferland	Cobalt	Cobalt
City of Cobalt Mining Company, Limited	City of Cobalt	Cobalt	Cobalt.
Cobalt Comet Mines, Limited	Drummond	Cobalt	Giroux Lake.
Cobalt Lake Mining Company, Limited	Cobalt Lake	Cobalt	Cobalt
Cobalt Townsite Mining Company, Limited	Townsite	Cobalt	Cobalt
Cochrane Mines of Cobalt, Limited	Cochrane	Cobalt	Haileybury.
Colonial Mining Company, Limited	Colonial	Cobalt	Cobalt
Coniagas Mines, Limited, The	Coniagas	Cobalt	Cobalt
Crown Reserve Mining Company, Limited	Crown Reserve	Cobalt	Cobalt
East Dome Mines, Limited	Silver Bar, under option	Cobalt	Cobalt
Hargrave Silver Mines, Limited, The	Hargrave	Cobalt	Giroux Lake.
Hudson Bay Mines, Limited, The	Hudson Bay	Cobalt	New Liskeard
Kerr Lake Mining Company, Limited	Kerr Lake	Cobalt	Cobalt.
La Rose Mines, Limited	La Rose	Cobalt	Cobalt.
Lumsden Mining Company, Limited, The	Lumsden	Cobalt	Cobalt.
Mann Mines	Mann	Gowganda	Gowganda.
McKinley-Darragh-Savage Mines of Cobalt, Limited	McKinley-Darragh and Savage	Cobalt	Cobalt.
Millerett Silver Mining Company, Limited.	Millerett	Gowganda	Gowganda.
Nipissing Mining Company, Limited	Nipissing	Cobalt	Cobalt.
O'Brien, M. J.	O'Brien	Cobalt	Cobalt.
O'Brien, M. J.	Miller Lake O'Brien	Gowganda	Gowganda.
Penn-Canadian Mines, Limited	Penn-Canadian	Cobalt	Cobalt
Porcupine Syndicate & Gould Consolidated	Gould	Cobalt	Cobalt.
Right-of-Way Mines, Limited, The	Right-of-Way	Cobalt	Cobalt.
Seneca-Superior Silver Mines, Limited	Seneca-Superior	Cobalt	Cobalt.
Temiskaming Mining Company, Limited	Temiskaming	Cobalt	Cobalt.
Trethewey Silver Cobalt Mine, Limited	Trethewey	Cobalt	Cobalt.
Wettlaufer-Lorrain Silver Mines, Limited.	Wettlaufer-Lorrain	Lorrain Tp.	Silver Centre.
York-Ontario Silver Mines, Limited	York Ontario	Cobalt	Cobalt
Non-Producing.			
Caleta Silver Mines, Limited	Location L357 358	Gowganda	Gowganda.
Canadian Gold and Silver Mining Company			
Cobalt Provincial Mining Company, Limited	Provincial	Cobalt	Giroux Lake
Downey Property	Downey	Mickle Tp.	North Bay.
Associated Gold Mines of Western Australia, Limited	Keeley	South Lorrain	Haileybury.
Peterson Lake Silver Cobalt Mining Company, Limited	Peterson Lake	Cobalt	Cobalt.

The Market for Cobalt

This is one metal the actual consumption of which has probably decreased, contrary to the enormous expansion in the use of practically all other metals. Friedrich Kapff's work, published in 1792, which gives a report on all the works making cobalt blue at that time in Germany, has been alluded to in previous reports of the Bureau (Vol. XIX, Part 2). From this it would appear that the works outside of Holland made about 3,000 tons of cobalt blue yearly. If the Holland works were added the total quantity would probably be 4,000 to 5,000 tons yearly of the blue color. This contained from 3 to 15 per cent. cobalt, the amounts of the high percentage material not being so great as the lower. Probably the average of the whole would have been 6 or 7 per cent. At the time the Cobalt district was discovered the total consumption of cobalt for the world likely did not equal 300 tons yearly of the metal. From the table given below it will be seen that the refiners of Ontario cobalt ores produced cobalt oxide which contained 216.8 tons of the metal. In addition to this 357 tons of cobalt ore and cobalt-bearing residues were shipped for which the owners received $23,473. This would probably increase the total metal from Ontario ores by about 30 tons.

Bounties on Cobalt and Nickel

Under the Metal Refining Act, Chap. 33, R.S.O. 1914, a bounty of 6 cents per lb. metal in cobalt or nickel oxide or metal is paid on such product as is refined in the Province. This bounty expires in 1917. The following amounts were paid for oxides produced in 1913:—

Name of Company.	Location.	Metal in Cobalt Oxide	Metal in Nickel Oxide	Bounty
		lb.	lb.	$
Coniagas Reduction Co., ...	St.Catharines...	325,811	149,645	28,527.36
Deloro Mining and Reduction Co., ...	Deloro..........	104,574	....	6,274.44
Standard Smelting and Refining Co..	North Bay......	3,582	....	214.92
Total........................	....	433,967	149,645	35,016.72

Nickel

An overwhelming proportion of the nickel supply of Ontario is obtained at present from the Sudbury district, the Alexo mine accounting for only 0.06 per cent. of the output. The output of the Sudbury mines was 780,101 tons, and was distributed as follows:—

	Tons.
Creighton mine	418,525
Crean Hill mine	56,646
No. 2 mine	56,439
No. 3 mine (Frood)	86,665
Garson mine	113,403
Victoria No. 1	38,592
North Star	11,294
Worthington	537
	780,101
Alexo mine	4,596
Total	784,697

The amount of ore smelted was somewhat greater, viz.: 823,403 tons; more was taken from the roast heaps than was put into them during the year.

The metal content and value of the ore smelted are given in Table VIII.

Progress of Nickel Mining

The progress can best be seen by reference to Table VIII., which gives the statistics for the years 1909 to 1913, and shows that the ore production rose from 452,000 to 785,000 in round numbers during that period. Both of the companies operating have extended and practically rebuilt their works, the Mond Nickel Company having removed all their smelting operations from Victoria Mines, about twenty miles west of Sudbury, to Coniston, about nine miles east.

Copper

The total copper production of Ontario was 12,941 tons, all of which, except three tons, coming from the copper-nickel mines of Sudbury and the Alexo mine in Dundonald township. The three tons mentioned were contained in the concentrate from the Temiskaming mine at Cobalt.

The 47,150 tons matte produced at Sudbury contained 37,760 tons nickel and copper combined, or 80 per cent. approximately of metal. Calculating from the 823,403 tons ore smelted, with no allowances for loss, this gives 3.02 per cent. nickel and 1.57 per cent. copper, or approximately 2 to 1.

The increased production in nickel and copper is shown by the following table:—

Table No. VIII.—Nickel-Copper Mining, 1909 to 1913.

Schedule.		1909	1910	1911	1912	1913
Ore raised	tons	451,892	652,392	612,511	737,656	784,697
Ore smelted	"	462,336	628,947	610,788	725,065	823,403
Bessemer matte produced	"	25,845	35,033	32,607	41,925	47,150
Nickel contents	"	13,141	18,636	17,049	22,421	24,838
Copper contents	"	7,873	9,630	8,966	11,116	12,938
Value of Nickel	$	2,790,798	4,005,961	3,664,474	4,722,040	5,237,477
Value of Copper	$	1,122,219	1,374,103	1,281,118	1,581,062	1,839,438
Wages paid	$	1,234,904	1,698,184	1,830,526	2,357,889	3,291 956
Men employed	No.	1,796	2,156	2,439	2,850	3,512

The nickel mining concerns carrying on active work are:—

Name of Company.	Name of Mine.	Location.	P.O. Address of Manager, etc.
Canadian Copper Company	Creighton, Crean Hill, No. 2, etc.	Sudbury	Copper Cliff
Mond Nickel Company, Limited	Victoria, Garson	"	Coniston
E. F. Pullen	Alexo	Dundonald Tp.	Cochrane

Platinum and Palladium

The Sudbury ores in some cases contain very small quantities of the precious metals, including platinum and palladium. The last Report of the Bureau showed that in six years, 1907 to 1912 inclusive, the average production per year of the matte treated by the Orford refining works had amounted to 394 oz. platinum and 702 oz. palladium. The value of both these metals is over $40 per oz.

Iron Ore

Four companies shipped ore during the year; the names appear in the list below. A certain amount of roasted ore was shipped from the Magpie mine at Michipicoten. The ore is a siderite impregnated with some pyrite; when roasted it produces material of an excellent quality. This ore contains a little manganese. The Moose Mountain mine at Sellwood, north of Sudbury, shipped a few thousand tons of briquettes made from slimes produced by wet magnetic concentration. All of the ore at this mine is of such a grade that it must first be concentrated. A small amount of the total production was from Hastings county.

The total ore production was 195,937 tons, with value of $424,072. Of this approximately 90,000 tons were exported.

The following is a list of companies operating:—

Iron Mining Companies, 1913

Name of Company.	Name of Mine.	Locality.	P. O. Address of Manager, etc.
Producing Companies:—			
Algoma Steel Corporation, Limited	Helen	Michipicoten	Helen Mine.
	Magpie	Michipicoten	Magpie Mine.
Buffalo Union Furnace Company	Belmont	Hastings county.	51 Hamburg Street, Buffalo, N.Y.
Canada Iron Mines, Limited	Childs Bessemer	Hastings county.	Trenton.
Moose Mountain, Limited	Moose Mountain	Sudbury Dist.	Sellwood.
Non-producing Company:—			
Atikokan Iron Company Limited	Atikokan	Port Arthur Dist	Port Arthur.

Pig Iron and Steel

In 1913 there were ten blast furnaces in operation in Ontario, which had an output of 648,899 tons. The number of employees at the blast furnaces only was 1,014. Of the total pig iron made 16,470 tons were charcoal iron. To produce this quantity of pig iron 1,228,269 tons of ore and 25,817 tons scale and mill cinder were used. The table below gives all the details of materials used and output for the last five years. It shows a steady increase in the steel output.

Table IX.—Production Iron and Steel, 1909 to 1913

Schedule.		1909	1910	1911	1912	1913
Ontario ore smelted	tons	220,307	143,284	67,631	71,589	132,708
Foreign ore smelted	"	543,544	678,890	848,814	1,062,071	1,095,561
Limestone for flux	"	226,991	248,750	275,628	305,509	351,741
Coke	"	436,707	471,493	577,388	660,248	706,852
Charcoal	bush	973,413	1,133,419	1,666,897	1,886,748	2.206,191
Pig iron	tons	407,013	447,351	526,610	589,593	648,899
Value of pig iron	$	6,301,528	6,975,418	7,716,314	8,054,369	8,719,892
Steel	tons	296,031	331,321	361,581	457,817	648,948
Value of steel	$	6,759,960	7,855,407	9,505,013	8,071,339	11,230,109

The following companies were producers of pig iron in 1913:—

Name of Company.	No. of Furnaces.	Fuel.	Location.
Canada Furnace Co.	1	Coke	Midland.
Algoma Steel Corporation	3	"	Sault Ste. Marie.
Steel Company of Canada	2	"	Hamilton
Standard Iron Co.	1	Charcoal	Deseronto.
" "	1	"	Parry Sound.
Canada Iron Corporation	2	Coke	Midland.

Materials of Construction

Nearly all the materials used in construction showed an increase over 1912. Common brick is the most important; in amount it was 386,882 M and in value $3,283,894. Paving and fancy brick were 18,547 M in amount and $213,119 in value. Pressed brick showed a substantial increase in output, being 76,138 M, worth $871,291. Sand lime brick had a value of $459,699. Sewer pipe to the value of $600,297 was made, and 14,265,000 drain tiles worth $251,705. Building stone, including crushed stone for road metal, totalled $1,117,153 in value. Lime amounting to 2,300,991 bushels, with a value of $390,600, was made. As shown in a following page, there was an increase in the production of Portland cement. Returns received show that sand and gravel to the value of $233,567 were produced during the year.

Following are lists of clay-working plants, lime manufacturers, and stone quarries:

List of Clay-Working Plants

Name.	Address.	Manufacture.
Adamson, William	Walkerton	Tile.
Allen, Solomon	Brantford	Brick.
Alsip Brick & Tile Co.	Fort William	Brick.
Armstrong, George H.	Brigden	Hollow Blocks and Tile.
Arnold, Willard	Pefferlaw	Brick.
Ashbridge Brick Co.	Toronto	Brick.
*Baeckler, William	Chesley	Brick.
Baird & Son, H. C.	Parkhill	Brick and Tile.
Baker, George E.	Arnprior	Terra Cotta, Brick and Tile.
Baker Bros.	Casselman	Brick.
Bartonville Pressed Brick Company, Limited	Bartonville	Pressed Brick.
†Beaverton Clay Products Co.	Beaverton	Brick.
Beckett, E. C.	Orwell	Brick and Tile.
Bell, John H.	Harriston	Brick.
Bell Bros.	Drew	Tile.
Bell Bros.	Paisley	Brick and Tile.
Bell Bros. & Co.	Toronto	Brick.
Belleville Pottery Co.	Belleville	Pottery.
Bemrose, Thos.	Beeton	Brick and Tile.
‡Big Four Brick Company, Limited	Toronto	Brick.
*Blake, Elias D.	Elginfield	Brick.
*Blake, W. C.	Nairn	Brick.
Bogart Bros.	Southwold	Tile.
Bond & Bird	Woodstock	Brick.
Boone, George H.	Thornbury	Brick.
Bowler, Wes.	Markdale	Brick.
Brampton Pressed Brick Company, Limited	Brampton	Pressed Brick.
Brandon Pressed Brick & Tile Co., Limited	Milton	Pressed Brick.
Brantford Brick Co., Limited	Brantford	Brick
Broadwell, Benj.	Kingsville	Brick and Tile.
Brown, J. W.	Vienna	Tile.
Brown Bros. Brick Co.	Mount Dennis	Brick.
Brownscombe & Sons, H.	Cargill	Brick and Tile.
*Buchanan Bros & Co.	Thessalon	Brick.
Buck, J. L.	Port Rowan	Brick and Tile.
Burgess, C. F.	Carleton Place	Brick.
Bushell, William	Toronto	Brick.
Butwell Brick Co.	Humber Bay	Brick.
Cabana, Jr., Oliver	St. Joseph	Brick and Tile.
Cairo Brick & Tile Works	Cairo	Brick and Tile.
Campbell, Neil F.	West Lorne	Brick and Tile.
‡Canada Brick & Fire Proofing Co., Limited	Terra Cotta	Brick.
Card, N. B.	Harrisburg	Brick and Tile.

List of Clay-Working Plants—Continued

Name.	Address.	Manufacture.
*Caswell, Edgar	Cobden	Brick and Tile.
Clemens, Moses	Thamesville	Brick and Tile
Conway, F. P.	Stratford	Brick and Tile
Cooper, W. H.	Ancaster Tp., Hamilton	Brick.
Cornhill & Son, James	Chatham	Brick.
Cranston & Son, J.	Hamilton	Pottery.
Crawford Bros.	Hamilton	Brick.
*Credit Forks Brick & Tile Co.	Toronto	Brick and Tile.
Crowhurst, W. J.	Port Hope	Brick.
Cumberland, J. M.	Listowel	Tile.
Curtis Bros.	Peterboro'	Brick and Tile
Davenport, B. F.	Orwell	Brick and Tile
Davis & Son, John	Toronto	Pottery.
Deller & Sons, Geo.	Norwich	Brick and Tile
Deller Bros.	Thorndale	Tile.
Dodge, Geo.	Kerrwood	Tile.
Dominion Brick & Tile Company, Limited	Breslau	Brick.
Dominion Sewer Pipe Co., Limited	Waterdown Sta.	Brick.
Dominion Sewer Pipe Co., Limited	Swansea	Sewer Pipe.
Don Valley Brick Works	Todmorden	Common Brick, Pressed and Fancy Brick, Terra Cotta, etc.
*Dryden Timber & Power Co., Limited	Dryden	Brick.
Dublin Brick & Tile Works	Dublin	Brick and Tile
*Dunlop & Schmidt	Pembroke	Brick.
Elliott, William	Glenannan	Brick and Tile
*Emard, Trefflé	Embrun	Brick.
*Farah, K.	New Liskeard	Brick.
Forman, Stephen	St. Mary's	Hollow Blocks and Tile.
Foley Consolidated Brick & Tile Co., The F. J.	West Toronto	Brick and Tile
Foster Pottery Co.	Hamilton	Pottery.
Fox, G. J.	Dresden	Brick.
Frank, C. D.	Strathroy	Brick.
Frazer & Logan	Blyth	Brick and Tile
Freek, William	Barrie	Brick.
Frid Brick Co., Geo.	Hamilton	Brick.
Frid Bros.	Hamilton	Brick.
Frost, Geo. H.	Toronto	Brick.
Fuller, Geo.	Dracon	Brick and Tile
Gardiner, William	Blenheim	Tile.
Govenlock, J. M.	Winthrop	Brick and Tile
Gowanlock, J.	West Fort William	Brick.
Hall, Mrs. Henry	Cobourg	Brick.
Hallett, H.	Comber	Brick and Tile
Hallman, J. B.	Hanover	Brick.
Halton Brick Co., Limited	Tp. of Esquesing	Pressed Brick.
Hamilton and Toronto Sewer Pipe Company, Limited	Hamilton	Sewer Pipe.
Hamilton Pressed Brick Co., Limited	Hamilton	Pressed Brick.
Hamley, R. H.	Bowmanville	Brick and Tile
Hancock, William	Hamilton	Brick.
Hicks, David	Shelburne	Tile.
Hill & Sons, James S.	Madoc	Brick.
Hill Bros.	Essex	Brick and Tile
Hinde Bros.	West Toronto	Brick.
Hiscock & Sons	Cobourg	Brick.
Hitch, John	Ridgetown	Brick and Tile
Hohl, Geo.	Lisbon	Brick and Tile
Holton Bros.	Drew	Brick.
Howlett, Fred.	Petrolea	Brick and Tile.
Humberstone, Thos. Allan	Newton Brook	Pottery.
Irwin, W. J.	Proton Sta.	Brick and Tile.
*James, Wm.	Blackwell	Brick.
Jamieson, J. A.	Renfrew	Brick and Tile.

List of Clay-Working Plants—Continued

Name.	Address.	Manufacture.
Janes, H.	Delaware	Brick and Tile.
Jervis & Son, John	Dorchester Sta.	Brick and Tile.
Johnson, James	Pembroke	Brick.
Johnston, Joseph	West Monkton	Brick and Tile
Jordan, Daniel	Chatham	Brick and Tile
Kaar, John	Brownsville	Tile.
Kerr, Fred.	Crediton East	Brick and Tile
Koebel, Joseph Z.	St. Clement's	Brick and Tile
Kruse Bros.	Egmondville	Brick and Tile.
Kuhn, Henry J.	Crediton East	Tile.
*Lang Bros.	Merrickville	Brick.
Launders, Thos.	Fruitland	Brick.
Leamington Brick & Tile Co., Limited	Leamington	Brick and Tile.
Leatherdale, R. W.	Dresden	Tile.
Lethbridge, W. W.	Steelton	Brick.
*Lichty, J. B.	Wellesley	Brick.
Light, William	Aylmer	Brick and Tile.
Lindsay, Stephen	Tupperville	Tile.
Lines, J. C.	Earlscourt	Brick.
Lingham, W. T.	Belleville	Brick.
Logan, John	Toronto	Brick.
Lowe, Gordon	Kent Centre	Brick and Tile.
Mackay Bros.	Dutton	Brick and Tile.
Marshall, W. W.	Hamilton	Brick.
Martin, David	Thamesville	Brick and Tile.
Mason, Charles	Toronto	Brick.
*Mawhinney, Robt.	Lovat	Brick.
Meaford Brick Co., Limited	Meaford	Brick.
Merkley Bros.	Casselman	Brick.
Maloney, John	Humber Bay	Brick.
Mills, Geo. E.	Hamilton	Brick.
Milton Pressed Brick & Sewer Pipe Co., Limited	Milton	Pressed Brick.
Miner, J. T.	Kingsville	Brick and Tile.
Moody, G. W.	Highgate	Brick and Tile.
*Montoux Bros.	Topping	Brick.
Morley, Walker	Toronto	Brick.
Morley & Ashbridge	Toronto	Brick.
*Mouldey, John	Bath Road	Brick.
Mullinex, W. C.	Hepworth	Brick.
Munro, D. W.	Carp	Brick and Tile.
*Murray, Timothy	Gad's Hill	Brick.
McCormick Bros.	Kingscourt	Brick and Tile.
McCracken Corporation, Limited	Windsor	Brick and Tile.
McCredie, W.	Lyons	Brick and Tile.
*McDonald & Reasbeck	Plantagenet	Brick.
McGibbon, Dugald	Shedden	Brick and Tile.
McLean Bros.	Brigden	Tile.
McLoughlin, John	London	Brick.
Napanee Brick & Tile Co., Limited	Napanee	Brick.
National Fire Proofing Co. of Canada, Limited	Waterdown	Terra Cotta, Hollow Tile, Fire-proofing.
Nayler & Son, J. W.	Trenton	Brick.
New, Edward	Hamilton	Brick.
Norton, Alsey	Bolton	Brick and Tile.
Norton, David	Woodbridge	Tile.
Norton, T. W.	West Toronto	Brick.
Oakville Pressed Brick Co.	Oakville	Brick and Tile.
Ollmann Bros.	Hamilton	Brick.
Ontario National Brick Co., Limited	Cooksville	Shale Brick
Ontario Paving Brick Co., Limited	West Toronto	Paving Bricks and Blocks
Ontario Sewer Pipe Co., Limited	Mimico	Sewer Pipe.
O'Reilly, T. E.	Ottawa	Brick.
Ott Brick & Tile Co., Limited	Berlin	Brick.

List of Clay-Working Plants—Continued

Name.	Address.	Manufacture.
Ottawa Brick Manufacturing Co., Limited	Ottawa	Brick.
Owen Sound Brick Co., Limited	Owen Sound	Brick.
*Paisley & Chisholm	Kingston	Brick.
Parks, H. W.	Dresden	Tile.
Paxton & Bray	St. Catharines	Brick.
Pears & Son, James	Toronto	Brick.
Pears, William	West Toronto	Brick.
Peerless Brick & Tile Co., Limited	Ottawa	Brick.
Pembroke Brick Co., The	Pembroke	Brick.
Petty, Chas.	Cherrywood	Brick and Tile.
Phillips, Thos.	St. Helen's	Tile.
Phinn, Geo. E.	Elginfield	Brick and Tile.
Pilon, A.	Casselman	Brick.
Piper, Murphy & Walsh	West Fort William	Brick.
Ponsford, A. E.	St. Thomas	Brick and Tile.
Port Credit Brick Co., Limited	Port Credit	Common Brick and Pressed Brick.
Port Dover Brick & Tile Co.	Port Dover	Brick and Tile.
Price, John	Toronto	Brick.
Prices, Limited	Toronto	Brick.
Reed, Mrs. A.	Foxboro	Tile.
Richardson & Son, James	Kerrwood	Brick and Tile.
Ries, John	Carlsruhe	Brick and Tile.
Rilett, David	Oil Springs	Tile.
Rilett & Holme	Alvinston	Brick and Tile.
Robinet Brick Co., Limited	Sandwich	Brick.
Russell, Joseph	Toronto	Brick.
*Russell Brick & Tile Co., Limited	Russell	Brick and Tile.
Ryan & Co., T. M.	Niagara Falls	Brick.
Schaefer Brick Co., Limited	New Hamburg	Brick and Tile.
Scott, James M.	Meaford	Brick and Tile.
*Shuttleworth & Co.	Petrolia	Brick.
Sinden, L. H.	Tillsonburg	Brick and Tile.
Sipprell, J. H.	Wilksport	Brick and Tile.
Smith, Allan G. C.	Acton	Cement Blocks and Tile.
Smith & Son, Alex.	Dutton	Brick and Tile.
Smith, W. W.	Shallow Lake	Brick and Tile.
Smith Bros.	Port Elgin	Brick.
Snelgrove & Teers	Beaverton	Brick and Tile.
Souter & Co., G. S.	Seaforth	Brick and Tile.
Sproat, Wm. M.	Toronto	Brick.
Standard Brick Co., Limited	North Bay	Brick.
Steele, Edwin	Vankleek Hill	Brick.
Stickwood, Chas.	Newmarket	Brick.
Sudbury Brick Co., Limited	Sudbury	Brick.
Stratford Brick, Tile & Lumber Co.	Stratford	Brick and Tile.
Stroh, Henry	Wallenstein	Tile.
Sun Brick Co., Limited	Toronto	Brick.
Superior Brick Co., Limited	Fort William	Brick.
Surridge, F.	West Toronto	Brick.
Taylor Bros.	Kemptville	Brick.
Taylor, James	Port Hope	Pottery.
Taylor & Hall	Peterboro'	Brick, Tile and Culvert Pipe.
Terra Cotta Pressed Brick Co., Limited	Terra Cotta	Pressed Brick.
Thornton, John	Perth	Brick.
Toronto Pressed Brick & Terra Cotta of Milton, Limited	Milton	Pressed Brick.
Turnbull, Robt.	Welland	Brick.
Voakes, Ed. R.	Wheatley	Brick and Tile.
Wagstaff, A. H.	Toronto	Brick.
Waide Bros.	London	Brick.
Waite, J. E.	Forester's Falls	Brick and Tile.

List of Clay-Working Plants—Concluded

Name.	Address	Manufacture
Wallace & Son, R.	North Bay	Brick.
Wardle, John	Blenheim	Brick and Tile.
Waterloo Brick & Tile Co., Limited	Waterloo	Brick.
Watson Brick Co.	Bracebridge	Brick.
*Watterworth, Chas.	Wardsville	Brick and Tile.
Wehlann & Son	Rodney	Brick and Tile.
Weppler, Henry	Hanover	Brick and Tile.
*West Bros.	Campbellford	Brick and Tile.
*Wiser & Sons, Limited, J. P.	Prescott	Brick.
Woods, W. H.	Brockville	Brick.
Workman, James	Hamilton	Brick.
Wright, Samuel	Chesley	Brick and Tile.
Wright Bros.	Kincardine	Brick and Tile
Yaeck, Louis	Walkerton	Brick.

*Not working in 1913. †No return from them. ‡In course of construction.

List of Sand-lime Brick Manufacturers

Name.	Address.
Canada Sand-lime Pressed Brick Co., Limited	West Toronto.
Harbour Brick Company, Limited	Toronto.
John Mann Brick Company, Limited	Brantford.
Port Arthur Sand-lime Brick Co., Limited	Port Arthur.
Schultz Bros. Company, Limited	Brantford.
Silicate Brick Company of Ottawa, Limited	Ottawa.
Toronto Brick Company, Limited	Toronto.
Willcox Lake Brick Company, Limited	Willcox Lake.
York Sandstone Brick Company, Limited	East Toronto.

Total production of sand-lime brick for 1913 was 53,072 thousand, worth $459,699.25

The brick plants of Toronto and immediate vicinity produced 220,356 thousand brick, worth $2,034,974, of which 36,670,000 were sand-lime brick, having a value of $313,259; 28,540 thousand, with a value of $355,756, were pressed and fancy brick, terra cotta, etc., and 4,642 thousand, valued at $79,931, were paving brick.

Lime Producers

Name of Owner or Company.	Location.
*Alex. Alexander	Alton.
Geo. Annis	Orillia.
*Albert Appleyard	Georgetown.
M. A. Ball	Jordan.
Beachville White Lime Company, Limited	Beachville.
Patrick Bergin	Napanee.
Geo. Brown	Cataraqui
E. A. Brown (Oliver)	Owen Sound.
John Callan & Bros.	Innerkip.
W. M. Cameron	Carleton Place
Canada Lime Co., Limited	Coboconk.
David Chalmers	Owen Sound.
Delta Lime Company, Limited	Delta.
J. H. Duckett	Eugenia.
E. & F. Flieler	Clarendon Tp.
*Wm. Foote	Varna.
*Wm. Foster	Cheltenham.
E. Harvey, Limited	Rockwood.
*J. Hebert	Casselman.
Higginson & Stevens	Stepney.

Lime Producers—Continued

Name of Owner or Company	Location
Jamieson Lime Company	Renfrew.
*J. M. Jelly	Bowling Green.
*Kingston Penitentiary	Kingston.
J. Langman	Hawkestone.
Alfred Lavoie	St. Felix.
*Alfred Leslie	Puslinch.
G. D. Lumsden	Holstein.
J. MacTernan	Woodlawn.
*J. Marren	St. Andrews.
J. Marshall	Hamilton.
Jas. McGillivray	Durham.
Fred. McMillan	Havelock.
Peter Milton	Campbellford.
John Montgomery	L'Amable.
James Moore	Foxmead.
*J. Muldoon & Company	Toronto.
*Oneida Lime Company	Hamilton.
*Ontario Limestone and Clay Co., Limited	Shannonville.
*R. T. Parks	Troy.
Emerie Poirier	Apple Hill.
*T. A. Poole	Perth.
*John Quigley	Pakenham.
John A. Reeb	Port Colborne.
D. Robertson Company, Limited	Milton.
H. Robillard & Son	Ottawa.
J. S. Smith	Inverhuron.
*W. J. Smith	Beaverton.
Standard Chemical, Iron and Lumber Co.	Eganville.
Standard White Lime Company, Limited	St. Mary's.
The Toronto Lime Company, Limited	Limehouse.
Albert Wellman, Sr.	Belleview.

*Idle in 1913.

Stone Quarries

Name of Owner, Firm or Company.	Location.	Kind of Stone.
Ball, M. A.	Jordan	Limestone.
Bergin, Patrick	Napanee	do
Britnell & Company, Limited	Burnt River	do
Callan & Bros., John	Innerkip	do
Canada Crushed Stone Corporation, Limited.	Dundas	do
Canada Iron Corporation, Limited	Longford	do
Cartmell, Wm.	Thorold	do
Cook, J. S.	Wiarton	do
Coughlin, Daniel	Smith's Falls	do
*Credit Forks Brick and Tile Company	Toronto	
Empire Limestone Company	Sherkston	Limestone.
Farr, C. C.	Haileybury	do
Fleming, J. H.	Glenwilliams	Sandstone.
Fretz, Jacob M.	Vineland	Limestone.
Gallagher Lime and Stone Co., Limited	Hamilton	do
Gordon & Bruce	Lyndhurst	Granite.
Granite Crushed and Dimension, Limited	Washago	do
Hagersville Contracting Co., Limited	Hagersville	Limestone.
Hagersville Crushed Stone Company	Hagersville	do
Hamilton Works Department	Hamilton	do
Harrison & Beatty	Owen Sound	do (rubble).
Hastings Quarries, Limited	Actinolite	Granite.
Howey, Geo.	Nanticoke	Limestone.
Inter-Cities Quarries Company	Port Arthur	Trap Rock.

Stone Quarries—Continued

Name of Owner, Firm or Company	Location	Kind of Stone
*Kennedy, R. C.	Guelph	Limestone.
Kingston Penitentiary	Portsmouth	do
Longford Quarry Company, Limited	Longford Mills	do
Maloney, John	Puslinch	do
Markus & Company	Pembroke	do
Marshall, James	Hamilton	do
Murphy, J. S.	Tweed	do
Oliver & Webster	Owen Sound	do
Ontario Rock Company, Limited	404 Lumsden Building, Toronto	Trap Rock.
Perkins, G. A.	Owen Sound	do
Point Anne Quarries, Limited	Point Anne	do
Power City Stone Company, Limited	Niagara Falls	do
Queenston Quarry Company, Limited	St. David's	do
Reeb, John A.	Port Colborne	do
Robertson, D., & Company, Limited	Milton	do
Robillard & Sons, H.	Ottawa	do
Roddy & Monk	Kingston	do
Rogers, F., & Company	Terra Cotta	Sandstone.
St. Mary's Horse Shoe Quarry	St. Mary's	Limestone.
*T. Sidney Kirby Company, Limited	Ottawa	Sandstone and Limestone.
Thames Quarry Company, Limited	St. Mary's	Limestone.
Thibeault, Adelard	Carleton	do
Thunder Bay Contracting Company, Limited	Port Arthur	Trap Rock.
*Tietz, Wm. A.	Waterford	Limestone.
Tweed Quarries, Limited	Tweed	Granite.
Webb, Geo. F.	Hamilton	Limestone.
*Webster, James S.	Galt	do
*Welk, Herman	Eganville	do
Wentworth Quarry Company, Limited	Vinemount	do
Wilson, G. S.	Manion	Sandstone.

*Idle in 1913.

Marble and Granite Quarries

Name of Owner, Firm or Company.	Kind of Stone.	Address.
Bannerman & Horne	Granite	126 Polson Avenue, Winnipeg, Man.
*Canadian Marble Company, Limited		16 Toronto St., Toronto.
*Central Ontario Marble & Granite Quarries		Trenton.
Ontario Marble Quarries, Limited	Marble	34 Price St., Toronto.

*Idle in 1913.

Sand and Gravel

Name of Owner, Firm or Company.	Location of Deposit.	P.O. Address of Manager, etc.
Armstrong Supply Company, Limited	York St., Hamilton.	
Barnes, Wm.	Stoney Creek	105 Dalhousie St., Hamilton.
Bartonville Gravel Pit	Bartonville	Brantford.
*Battle, John	near Port Maitland.	Thorold.
*Buchanan, John Alexander	Point Pelee	Windsor.
Canada Pebble Company, Limited	Jackfish	Port Arthur.
Clifton Sand and Gravel Company	Stamford	St. Catharines.
Empire Limestone Company	Sherkston	Buffalo, N.Y.
Fineout, Geo. H.	Black Bar, Lamb Island, etc.	Port Arthur.
*Fraser, John	Tp. of Malden	Amherstburg.
*Grubb, William A.	Leamington	Leamington.
Hagerman, Anson V.	Fellows	Fellows.
Hansen, Hans Christian	Pelee Island	7325 Clinton Ave., Cleveland, Ohio.
Kingston Sand and Gravel Company	Tp. of Kingston	Kingston.
New, Edward	York St., Hamilton.	133 George Street, Hamilton.
Ollmann Bros.	Between Macklin St. and Paradise Rd., Hamilton	Hamilton.
Penhorwood, Sydney Lewis	Sault Ste. Marie.	Sault Ste. Marie.
Smith & Company, Home	Jane St., West Toronto	Lambton Mills.
Todd, Eldoras	Bartonville	336 Main St. East, Hamilton.
Webb, M. M.	Burlington Heights.	Hamilton.
York Sand and Gravel Company	Scarboro, York Co.	Toronto.

*Not operating in 1913.

Portland Cement

This product showed an increase of about 800,000 barrels over the previous year, and was 3,802,321 barrels, with value of $4,105,455. Most of it is now made from limestone instead of from marl, as formerly.

Portland Cement Plants

Name of Company.	Location of Plant.	P.O. Address of Manager, etc.
*Ben Allen Portland Cement Co., Limited	Benallen	R.R. No. 7, Owen Sound.
Canada Cement Company, Limited, Plant No. 4.	near Belleville	Herald Bldg., Montreal, Que.
do do do No. 5.	near Belleville	do do
do do do No. 6	near Marlbank	do do
do do do No. 7	near Lakefield	do do
do do do No. 8	near Port Colborne.	do do
do do do No. 9	near Shallow Lake.	do do
The Hanover Portland Cement Co., Limited	Hanover	Hanover.
The Imperial Cement Company, Limited	Owen Sound	Owen Sound.
Maple Leaf Portland Cement Co., Limited	Atwood	Listowel.
National Portland Cement Co., Limited	Durham	Durham.
The Ontario Portland Cement Co., Limited	Blue Lake	Brantford.
St. Mary's Portland Cement Co., Limited	St. Mary's	St. Mary's.
Superior Portland Cement Co., Limited	Orangeville	Box 134, Orangeville.

*In course of construction.

Other Minerals and Mineral Products

Arsenic

All the arsenic produced during the year was a by-product from the silver-bearing ores of the Cobalt district. In all 2,450,758 pounds, with a value of $64,146, were made and shipped, the average price being about 2.6 cents per lb.

Refineries of Cobalt-Silver Ore

(Producers of White Arsenic)

Name of Company.	P.O. Address of Manager, etc.
The Coniagas Reduction Company, Limited	St. Catharines.
The Deloro Mining and Reduction Company, Limited	Deloro.
Dominion Refineries, Limited	North Bay.
Metals Chemical Company, Limited	Welland.

The amount of pyrites mined and shipped in 1913 was 71,620 tons, with a value of $171,687. This is somewhat greater than for the previous year.

Of the producers given below, the Nichols Chemical Company have an acid works and make acid at the mine.

The following were the producers for 1913:

Iron Pyrite Producers, 1913

Name of Owner, Firm or Company.	Location or name of Mine	P.O. Address of Manager, etc.
Algoma Steel Corporation, Limited	Helen	Sault Ste. Marie.
Canadian Sulphur Ore Company, Limited	Queensboro	404 Lumsden Building, Toronto.
Nichols Chemical Company, Limited	Sulphide	Sulphide.
Northern Pyrites Company	Vermilion Lake	Northpines.
Sulphide Chemical Company, Limited	Sulphide	Sulphide.

Gypsum

The gypsum is obtained in the vicinity of Caledonia, Haldimand county. The production for the year was 40,581 tons, valued at over $92,000, as against $50,000 for the previous year.

Gypsum Mines

Name of Owner, Firm or Company	Location of Mines	P.O. Address of Manager, etc.
The Alabastine Company of Paris, Limited.	Caledonia	Paris.
Crown Gypsum Company, Limited	Lythmore	Lythmore.
*William Smith	Caledonia	Caledonia.

*Not producing in 1913.

Salt

The salt production shows little change from year to year. It is all derived from wells near Lakes Huron and St. Clair. The yield for 1913 was 96,799 tons, valued at $474,372, being a slight increase over the previous year.

The salt producers are given below:—

Salt Companies

Name of Owner, Firm or Company.	Location of wells or works.	P.O. Address of manager, etc.
The Canadian Salt Company, Limited	Windsor Sandwich	Windsor.
*Carter & Kittermaster	Mooretown	175 Christina St. S., Sarnia.
The Dominion Salt Company, Limited	Sarnia	Sarnia.
The Elarton Salt Works Company, Limited.	South of Egremont Road	Hyde Park.
Exeter Salt Works Company, Limited	Exeter	Exeter.
The Gray, Young & Sparling Company of Ontario, Limited	Wingham	Wingham.
Ontario People's Salt & Soda Co., Limited	Kincardine	Kincardine.
John Ransford	Stapleton	Clinton.
Western Canada Flour Mills Co., Limited	Goderich	Goderich.
The Western Salt Company, Limited	Mooretown and Courtright	Courtright.

*Not producing in 1913.

Calcium Carbide

All the production came from the works of the Canadian Carbide Company, Merritton, the output being 2,052 tons.

Corundum

The output was 1,177 tons, with a value of $137,036. The address of the only operating company is given below:

Name of Company.	Location of mines	P.O. address of manager, etc.
Manufacturers Corundum Co., Limited	Carlow Tp. and Craigmont	712 Traders Bank Building, Toronto.

Feldspar

The output of this mineral shows a substantial increase both in amount and value, the figures being 18,615 tons, with a value of $73,338. During the year a factory for the manufacture of floor tiles was erected at Kingston. Ground feldspar is used as one of the ingredients of the tile.

The producers of feldspar are:

Feldspar Mines

Name of Owner, Firm or Company	Location of mine	P.O. address of manager, etc.
Dominion Feldspar, Limited	Parham	30 Adelaide St. W., Toronto.
Dominion Improvement & Development Co.	N. Burgess Tp.	Box 26, Perth.
Charles Jenkins	Bedford Tp.	Petrolia.
Kingston Feldspar and Mining Company	Desert and Reynold mines	Kingston.
McDonald Feldspar Company, Limited	Verona	720 Traders Bank Toronto.
Ojaipee Company, Limited	Parry Sound	375 Spadina Ave., Toronto.

Graphite

This mineral also shows an increase, the amount of refined graphite being 1,788 tons, with a value of $93,054.

Graphite Properties

Name of Owner, Firm or Company.	Location of mines or works.	P.O. address of manager, etc.
J. G. Allan		211 Bay St. South, Hamilton.
Black Donald Graphite Company, Limited	Whitefish lake	Calabogie.
The Globe Refining Company, Limited	N. Elmsley Tp.	175 Cooper Street, Ottawa.
Tonkin du Pont Graphite Co., Limited	Wilberforce	Wilberforce.

Quartz

By far the greater part of the quartz mined is used by the Canadian Copper Company as a flux in their nickel-copper smelting operations, but a smaller quantity, together with quartzite, is used in other plants. The total production for the year was 54,320 tons, with value of $130,860.

Quartz Producers

Name of Owner, Firm or Company.	Location of mines	P.O. address of manager, etc.
The Canadian Copper Company	Dill	42 Exchange Place, New York.
The McPhail & Wright Construction Co., Ltd	Mile 19, A. C. Ry.	Sault Ste. Marie.
The Mond Nickel Company, Limited	Neelon Tp.	Coniston.
A. B. Willmott	Killarney	404 Lumsden Bldg., Toronto.

Talc

The production of this mineral shows a marked increase both in quantity and value, the amount being 17,988 tons, worth $100,480. As the qualities of Ontario talc become better known the market is widened.

List of Talc Producers in Ontario, 1913

Name of Firm or Company	Location of mine or works	Address of manager, etc.
Cross & Wellington	Huntington Tp	Madoc.
Canadian Talc and Silica Company	Eldorado	Eldorado.
Geo. H. Gillespie Company, Limited	Madoc	Madoc.

Peat Fuel

Only 1,500 tons were produced during the year, all in the Shuttleworth plant.

Peat Plants

Name of Firm or Company	Location of plant	P.O. address of manager, etc.
J. McWilliam	Dorchester Tp.	402 Dundas Street, London.
J. M. Shuttleworth	Alfred	Peterboro.

Mica

The mica production for the year was smaller than in 1912, being 386 tons, but the value was practically the same and came to $55,264.

The following are the producers for the year:

List of Mica Mines and Companies

Name of Owner, Firm or Company	Name or location of mine	P.O. address of manager, etc.
*G. E. Allard	Loughborough Tp.	Rochester, N.Y.
Birch Lake Mining Co., Limited, The	Gould lake	115 York St., Ottawa.
*Brockville Mining Company	South Crosby Tp.	Elgin.
*Dominion Improvement & Development Co.	North Burgess Tp.	Box 26, Perth.
Dominion Mineral Exploration Syndicate	Loughborough	Box 148, Sydenham.
Wm. E. & S. Silas, C. Ennis	Tett's mine, Bedford Tp.	Perth Road.
Kent Bros. & J. M. Stoness	Taggart mine	Kingston.
*Kingston Feldspar and Mining Company		Kingston.
Loughborough Mining Co., Limited, The	Lacey mine	Sydenham.
W. L. McLaren	North Burgess Tp.	Perth.
*New York & Ontario Mica Company		Perth Road.
*Scriven and Whyte	Sydenham	Sydenham.
Tett Bros.	Bedford Tp.	Bedford Mills.
J. W. Trousdale	Gould lake	Sydenham.
*Edward Watts and J. J. Noble		Perth.

Those marked * did not produce any mica in 1913.

Petroleum

The decline in the petroleum output in 1913 was not so great as it has been for some years past. The greatest production was in 1895, when the output was about 830,000 barrels. In 1906 again, owing to the discovery of the Tilbury field, another peak in the production was reached.

By districts the yield is as follows:

	1912 Bbls.	1913 Bbls.
Lambton	150,272	155,747
Tilbury	44,727	26,824
Bothwell	34,486	34,348
Dutton	4,335	4,610
Onondaga	7,115	4,172
Belle River	....	465
Total	240,935	226,165

It will be seen that the decline is in Tilbury and Onondaga; Lambton shows a slight increase, which would no doubt have been greater had it not been for the havoc caused by severe gales on March 21st and November 10th, which blew down derricks and destroyed jerker lines, checking production for a time.

Prices for the year ranged from $1.68 to $1.89 per barrel, with an average of about $1.80, plus bounty.

Mr. John Scott, Inspector, reports that 773 wells in all were abandoned during the year, of which 655 were in Petrolea, 38 in Tilbury, and the balance distributed between Oil Springs, Bothwell, Raleigh, Camden and Zone township.

The Refining Companies are:—

Imperial Oil Company	Sarnia.
Canadian Oil Companies	Petrolea.
Canadian Oil Producing and Refining Company	Petrolea.
Empire Company	Wallaceburg.
British American Company	Toronto.

The production of crude petroleum for the years 1909-10-11, in order to make up a five-year period with the statistics already given, is as follows:—

Petroleum Production by Districts, 1909 to 1911

Field.	1909	1910	1911
	bbl.	bbl.	bbl.
Lambton	243,123	205,456	184,450
Tilbury and Romney	124,003	63,058	48,707
Bothwell	38,092	36,999	35,244
Leamington	5,929	141	....
Dutton	9,513	7,752	6,732
Onondaga (Brant Co.)	....	1,005	13,501
Total	420,660	314,410	288,634

As will be seen, the refineries import a large amount of crude oil, owing to the shrinkage in the production of the domestic crude.

Petroleum and Petroleum Products, 1909 to 1913

Schedule.		1909	1910	1911	1912	1913
Crude produced	Imp. gal.	14,723,105	11,004,357	10,102,081	8,432,730	7,915,761
Crude distilled	"	35,530,918	36,171,032	38,632,504	46,270,701	53,821,592
Value crude produced	$	559,478	368,153	353,573	344,537	381,159
Value distilled products	$	2,501,384	2,511,368	2,294,396	3,592,230	3,068,312
Illuminating oil	Imp. gal.	17,902,254	18,983,357	20,240,523	23,090,280	21,415,010
Lubricating oil	"	3,856,778	4,469,038	4,729,257	5,932,166	6,144,193
Benzine and naphtha	"	3,930,691	4,297,615	4,179,575	4,955,022	7,349,015
Gas and fuel oils and tar	"	4,687,588	5,876,498	4,847,124	6,028,983	10,157,948
Paraffin wax and candles	lb.	7,092,278	5,179,391	5,267,485	8,086,841	10,153,806
Workmen employed	No.	436	428	511	699	781
Wages paid	$	261,014	280,485	314,851	436,852	559,556

Natural Gas Industry in 1913

Mr. G. R. Mickle, Mine Assessor, furnishes the following notes on gas:

Natural gas was derived from the three fields during the year. A brief sketch of each is given in the report dealing with the Composition of Natural Gas in Ontario in this volume. This also contains a map showing the gas producing areas. The total production for the year was 12,558.4 million cubic feet, and the distribution is as follows: (This includes estimated production from a number of very small operators who make no returns).

	Million cubic feet.
Welland-Haldimand-Norfolk, etc.	4,115.8 or 32.7 per cent.
Kent	7,975.8 or 63.5 per cent.
Elgin	466.8 or 3.8 per cent.
	12,558.4 or 100 per cent.

This is almost identical with last year, both with regard to total and distribution. The total output for each field cannot be given in every case as in the early years of the productive life of the Welland-Haldimand field no complete record was kept of the output. The returns for 1906-13, both inclusive, show a total production of 30,007 millions for this field. For Kent the total now stands at 31,108 millions from the beginning of operations to the end of 1913, and for Elgin similarly 1,049 millions.

The old Welland-Haldimand field was extended by drilling a number of wells in Binbrook township, Wentworth county. This was the most interesting feature in connection with gas in the eastern part.

During the latter part of the year the drain on the Kent field was increased. The figures for next year will show a substantial advance in production.

The most important development in connection with the industry during the year was the discovery of a new field in Lambton county. During the summer of 1913 several wells were drilled In Enniskillen township at Oil Springs, and gas discovered in moderate quantity—several hundred thousand cubic feet capacity—but it was not till the Fairbanks well was drilled in March, 1914, and a well giving a larger flow of gas than any found hitherto in Ontario was disclosed, that the probable importance of this discovery was realized. It will be seen by reference to the analyses that this gas is quite different from any found hitherto in that part of the Province. Active drilling operations are now being carried on in that field to test the territory.

Dr. Fairbanks, owner of this well, kindly furnished the writer with the log for publication:

Fairbank Gas Well No. 1

Lot 18, Concession 2, Enniskillen
March, 1914

Surface	75 feet	
Top Soap	106 feet	
Lime	17 feet	
Lower Soap	34 feet....	232 feet
Limestone and Dolomite	998 feet....	1,230 feet
Salt	35 feet	
Dolomite	57 feet	
Salt and Hard Streak	238 feet....	1,560 feet
Brown Dolomite	166 feet	
Salt	40 feet....	1,786 feet
Dolomite	127 feet....	1,893 feet
Dolomite (Light)	5 feet....	1,898 feet
Dolomite Gas Rock	14 feet	
Total Depth		1,912 feet

Dr. Fairbanks in sending the log says: "Have omitted the big water vein and upper oil strata which all Oil Springs logs show." The oil strata are at 265 feet and 420 feet and water at 260 feet and 490 feet.

Regulations Concerning Gas and Oil Wells

Two Inspectors are kept in the field by the Department to enforce the regulations regarding the plugging of abandoned oil and gas wells. Mr. Donald Sharpe, who has charge of the Welland-Haldimand district, reports that in his district the drilling done during the year has made some welcome discoveries of gas. Thus the Provincial Natural Gas and Fuel Company of Niagara Falls, Ont., drilled two wells giving a measurement of more than a million feet each in the township of Bertie, which was supposed to be well explored.

The largest single producer in that district is the Dominion Natural Gas Company, which drilled 96 wells during 1913, of which 80 were productive.

During the year a pipe line 153 miles in length was laid from the Kent field to Hamilton, the reason for this being the difficulty of supplying the increased demand for gas from a territory in which the drilling is only able to maintain a stationary production.

In the western part of the Province the discovery of gas in Lambton county has been already alluded to under "Natural Gas in 1913" and also the "Composition of Natural Gas Found in Ontario."

Following is a list of the companies producing natural gas in 1913.

List of Natural Gas Producers in 1913

Name of Person or Company.	Locality.	P.O. address of manager, etc.
Aldrich Gas & Oil Company, Limited, The	Haldimand County	Selkirk.
Beaver Oil & Gas Co., Limited, The	Tp. of Romney, Kent County	66½ Market Street, Brantford.
Beck and Aikens	S. Cayuga and Dunn Tps.	Dunnville.
Bertie Natural Gas Company, Limited	Bertie Tp.	Ridgeway.
Canadian Gas Company	Kent County	1426 Dime Bank Building, Detroit, Mich.
Canfield Natural Gas Company, Limited	Canfield	Canfield.
Cheapside Gas and Oil Company, Limited	Haldimand County	Cheapside.
Chippewa Oil & Gas Company, Limited, The	Lincoln and Haldimand Counties	Tavistock.
Coleman, J. A.	Tp. of Wainfleet	Wellandport.
Commonwealth Oil and Gas Co., Limited	Tp. of Onondaga	165 Bay St. West, Hamilton.
Crystal Oil and Gas Co., Limited, The	Tp. of Onondaga	Paris.
Dauskin, D.	Tp. of Brantford	Cainsville.
Dominion Natural Gas Co., Limited, The	Counties of Lincoln, Wentworth, Elgin, Norfolk and Haldimand	842 Marine Bldg., Buffalo, N.Y.
Dunn Natural Gas Company, Limited, The		Dunnville.
Empire Limestone Company	Welland County	Buffalo, N.Y.
Enterprise Gas Company, Limited	Norfolk County	842 Marine Bldg., Buffalo, N.Y.
Gas & Oil Co. of Springvale, Limited, The	Walpole Tp.	Springvale.
Hagersville Light and Fuel Co., Limited	Hagersville	Hagersville.
Holmes Gas Company	Rainham & Walpole Tps.	Selkirk.
Home Natural Gas Company, Limited	Oneida Tp.	City Hall, Hamilton
Hoover, D. E.	Rainham Tp.	Rainham Centre.
Hoover, D. E., A. E., and Menno	Rainham Tp.	Rainham Centre.
Hoover, James E.	Walpole Tp.	Selkirk.
Humberstone Mutual Natural Gas & Fuel Co.	Humberstone	Humberstone.
Industrial Natural Gas Company	Tps. of Crowland & Humberstone	Port Robinson.
Kindy Gas Company	Rainham Tp.	Rainham.
Kindy, D., and Sons	Rainham Tp.	Selkirk.
Kohler and Aikens	Canboro Tp.	Dunnville.
Lalor, F. R.	Dunnville	Dunnville.
Lalor, Aikens and Smith	Sherbrooke and Dunn Tps.	Dunnville.
Lamb, Alfred	Walpole Tp.	Selkirk.
Lamb, Walter B. and R. W. Lamb	Walpole Tp.	Nanticoke.
Lint and Emerson	Canboro Tp.	Attercliffe Station.
Manufacturers Natural Gas Co., Limited (Distributor)		842 Marine Bldg., Buffalo, N.Y.
Marshall, James	Haldimand County	Hamilton.
Martin, Edward	Port Maitland	Port Maitland, Ont.
Mayer and Ross	Humberstone Tp.	202 Mutual Life Bldg., Buffalo, N.Y.
Medina Natural Gas Company, Limited, The	Elgin County	Chatham.
Midfield Natural Gas Company, Limited	Tp. of North Cayuga	32 Stinson St., Hamilton.
Moote, Melick and Lymburner	Haldimand County	Canboro.
Nanticoke Natural Gas Co., Limited, The	Nanticoke	Nanticoke.
National Gas Company, Limited	Haldimand & Wentworth Counties	Rainham Centre.
Niagara Natural Gas and Fuel Co., Limited	Humberstone Tp.	Sherkston.

List of Natural Gas Producers in 1913—Continued

Name of Person or Company	Locality	P.O. address of manager, etc.
Norfolk Gas Company, Limited	Norfolk County	842 Marine Bldg., Buffalo, N.Y.
North Shore Gas Company	Shore of Lake Erie.	Hamilton.
Northwestern Gas Company, Limited	Brant County	15 Scott Block, Erie, Pa.
Onondaga Oil and Gas Co., Limited, The	Onondaga Tp.	Brantford.
Oxford Oil and Gas Company, Limited	Innerkip Tp.	Brantford.
Port Colborne-Welland Natural Gas and Oil Company, Limited, The	Brant and Haldimand Counties	Port Colborne.
Port Rowan Natural Gas Company	Norfolk County	842 Marine Bldg., Buffalo, N.Y.
Producers Natural Gas Company, Limited	Haldimand County.	842 Marine Bldg., Buffalo, N.Y.
Provincial Natural Gas and Fuel Company of Ontario, Limited, The	Welland County	Niagara Falls, Ont.
Rolston, James, and Bennett, Robert	Canboro Tp.	Dunnville.
Snively, F. L.	Rainham and South Cayuga Tps.	Dunnville.
Southern Ontario Gas Company, Limited (Distributors)		St. Thomas.
Standard Natural Gas Company, Limited	Onondaga Tp.	Dunnville.
Standard Oil Company of Canada, Limited	Humberstone and Moulton Tps.	Port Colborne.
Sterling Gas Company, Limited	Kent County	Tilbury, Ont.
Telephone City Oil and Gas Co., Limited	Onondaga Tp.	Brantford.
Union Natural Gas Co. of Canada, Ltd., The.	Kent County	Niagara Falls, Ont.
United Gas Companies, Limited, The	Wainfleet Tp.	St. Catharines.
United Gas & Fuel Co. of Hamilton, Limited (Distributors)		72 James Street N., Hamilton.
Vansickle, A. W.	Onondaga Tp.	Onondaga.
Waines & Root Gas Co., Limited, The	Canboro, S. Cayuga, Dunn, Rainham & Walpole Tps.	Dunnville.
Welland County Lime Works Company	Port Colborne	Port Colborne.
Widrick, M.	Walpole Tp.	Nanticoke.

Mining Revenue

The revenue received by the Government for the fiscal year ending 31st October, 1913, was $621,392.97, being a decrease of $12,000 approximately from the amount received during the preceding year. For the two years the statement stands as follows:

Service	12 mos. ending 31st Oct., 1912	12 mos. ending 31st Oct., 1913
Sales of mining land	$51,634 48	$95,068 94
Rental, leases, etc.	33,098 34	20,878 43
Miner's licenses, permits, fees	107,162 70	93,256 10
Mining Royalties	250,145 65	200,333 01
Mining Tax Act	190,875 53	211,063 84
Provincial Assay Office	654 00	404 75
Diamond drills	208 25	387 90
	$633,778 95	$621,392 97

It will be noticed that the sales of land and the Mining Tax Act revenues show an increase, the former being chiefly due to patents granted in Porcupine as a consequence of the large number of claims staked in 1910. Leases, royalties and miner's licenses show a decrease.

The table following gives details of the transactions regarding land. The totals do not agree with those given above, the difference being due to the fact that the first figures represent the amounts actually received within the fiscal year, while the second are the monies pertaining to the transactions consummated during the year.

Mining Lands Sold and Leased for year ending October 31st, 1913

District.	Sales.			Leases.			Total.		
	No.	Acres.	Amount.	No.	Acres.	Amount.	No.	Acres.	Amount.
			$			$			$
Timiskaming	651	25,527.13	69,116 23	223	8,808.22	8,808 22	877	34,335.35	78,[illegible]
Nipissing	1	163	163	12	505.02	505 02	13	668.02	668 02
Sudbury	10	830.15	1,279 63				10	830.15	1,279 63
Algoma	45	1,931.66	1,946 45				45	1,931.66	1,946 45
Thunder Bay	67	3,860.92	9,299 87				67	3,860.92	9,299 87
Kenora	25	1,990	2,898 50				25	1,990	2,898 50
Elsewhere	15	971.51	1,127 50				15	971.51	1,127 50
Total	817	31,375	89,161 28	235	9,313.21	9,313 21	1,052	41,688.24	98,471 52

License and Recording Fees

The amount received under this head was somewhat less than in the preceding year. The various subdivisions are:

Miner's Licenses	$44,065 80
Forest Reserve Permits	995 00
Recording Fees	48,195 30
	$93,256 10

Royalties

The royalties, amounting to $200,333.01, were derived from the following sources:

The O'Brien Mine	$27,691 34
Crown Reserve Mining Company	93,650 78
Hudson Bay Mines	78,990 89
	$200,333 01

The total royalties paid by the various mines up to 31st October, 1913, stand as follows:

The O'Brien Mine	$695,067 85
Crown Reserve Mining Company	705,641 69
Hudson Bay Mines	324,261 21
Chambers-Ferland Mining Company	26,259 64
Hargrave Silver Mines	1,200 00
Waldman Silver Cobalt Mining Company	777 48
Wyandoh Mining Company	1,421 72
Cobalt Provincial Mines	6,735 14
	$1,761,364 73

Amount Collected on Account of Supplementary Revenue Act, 1907, for the year ending October 31st, 1913

Profit Tax	$173,532 65
Acreage Tax	13,915 70
Gas Tax	23,615 49
	$211,063 84

The Supplementary Revenue Act, 1907, now called "The Mining Tax Act," provided for the appointment of an officer called the Mine Assessor, with duties and powers under this Act. Mr. G. R. Mickle has occupied this position since the Act came in force in 1907 and furnishes the following statement:

Operations of the Mining Tax Act, R.S.O., 1914, Chapter 26, formerly called the Supplementary Revenue Act

There are three taxes levied under this Act, namely:

1. Profit tax—at the rate of 3 per cent. on the profits of mines in excess of $10,000, with the deduction of certain taxes paid municipalities.

2. Natural Gas tax—at the rate of two-tenths of a cent per thousand cubic feet, or $2.00 per million.

3. Acreage tax—2 cents per acre on all mining lands situated in territory with no municipal organization.

The amount collected under this Act for the calendar year, 1913, was $258,291.67, and is distributed as follows:

Profit tax	$221,960 78
Natural Gas tax	24,780 49
Acreage tax (April 15th, 1913, to April 15th, 1914)	11,550 40
	$258,291 67

This is approximately 25 per cent. more than the amount collected for 1912. There is an apparent increase in the profit tax of about $45,000, but approximately $19,000 of this belongs to 1912, and if this amount was deducted from 1913 and added to 1912 it would make the two very nearly equal in amount. There is an increase of about 25 per cent. in the Natural Gas tax. The Acreage tax is smaller, owing to overdue payments made on list advertised for forfeiture last year.

The Profit tax was contributed by seventeen different companies, the greater part coming from the silver mines of Cobalt. For the first time there is some revenue from the gold mines in the Province. Certain of the companies in the Cobalt district, paying a royalty to the Crown, may deduct any taxes paid from the royalty. Accordingly no tax is collected from these. If it were not for this fact the Profit tax would have been about $30,000 greater and the royalty less by an equal amount. For the next few years there is no material alteration in the total amount that will be paid as Profit tax in sight.

The Natural Gas tax was paid by fifty-two companies and individuals, some of the amounts being quite small. There will probably be an increase in this in the immediate future and then a decline unless new fields are discovered.

With regard to acreage tax, no attempt has ever been made to keep the different years separate. Payments are made at all times throughout the year and in many cases several years' taxes are paid at one time.

In these statements taxes are credited to the year to which they belong. In the cases of the Profit and Natural Gas taxes these are based on the operations of the preceding year. As the tax is not due until October, and the fiscal year of the Province ends on the 31st of October, some payments fall in the succeeding fiscal year, so that these statements can never agree with the Public Accounts.

Mining Companies

The number of mining, quarry and natural gas companies incorporated during the year was 119, with an aggregate capital of $78,000,000, the amount of capital being somewhat greater than was represented by the companies incorporated in the previous year and the number of companies a little less.

The business for which these companies have been organized takes in the whole range of mineral products.

In addition to these companies of domestic origin, a certain number incorporated elsewhere were licensed to do business in Ontrio.

Following are lists of both kinds:

Mining Companies Incorporated in 1913

Name of Company.	Head Office.	Date of Incorporation	Capital.
A. E. Ponsford, Limited (Brick)	St. Thomas	March 7	$60,000
Amalgamated Nickel-Copper Mining Company, Limited	Ottawa	June 5	1,000,000
Balsam Lake Quarries, Limited	Toronto	June 13	60,000
Barwick Mines Company, Limited	Emo	May 10	20,000
Black Fox Gold Mining Company, Limited	North Bay	September 9	1,000,000
Burnside Gold Mines, Limited	Haileybury	July 24	3,000,000
Calgary Brick and Supply Company, Limited	Toronto	May 26	200,000
Canada Feldspar Corporation, Limited	Toronto	September 3	100,000
Canadian Concrete Products Company, Limited	Toronto	April 21	50,000
Canadian Copper and Armour Plate Company, Limited	Toronto	December 31	1,000,000
Canadian Mineral Development Company, Limited	Toronto	July 30	40,000
Canadian Rand Goldfields, Limited	Toronto	September 22	1,000,000
Casey Majestic Mines, Limited	Toronto	December 17	40,000
Castings of Ottawa, Limited	Ottawa	August 8	40,000
Cleary Mines, Limited	Toronto	November 15	1,000,000
Clevenger-Prophet Silver Mines, Limited	Toronto	May 2	1,500,000
Cobalt Comet Mines Limited	Toronto	April 16	1,000,000
Cobalt South Silver Mining Company, Limited	Toronto	December 27	1,000,000
Cochrane Mines of Cobalt, Limited	Toronto	April 17	400,000
Commonwealth Gold Mines, Limited	Toronto	June 9	1,000,000
Consolidated Brick and Tile Company, Limited	Toronto	June 12	40,000
Co-Operative Brick Company, Limited	Toronto	September 5	1,000,000
Credit Forks Tile and Brick Company, Limited	Toronto	February 14	100,000
Crookston Stone Company, Limited	Toronto	June 13	50,000
Crystal Lake Mines, Limited	Toronto	July 29	40,000
Dominion Brick and Tile Company, Limited	Toronto	August 12	200,000
Dominion Reduction Company, Limited	Cobalt	September 15	2,000,000
Empire Marble Company, Limited	Toronto	February 17	1,000,000
Eureka Cement Pressed Brick Company, Limited	Toronto	June 16	40,000
Galeta Silver Mines, Limited	Toronto	May 22	500,000
General Exploration Company, Limited	Toronto	November 1	250,000
Gosselin Gold Mines, Limited	Toronto	May 31	2,000,000
Grand Gypsum, Limited	Hamilton	April 4	250,000
Gravenhurst Crushed Granite Company, Limited	Toronto	September 5	100,000
Gull Lake Gold Mines, Limited	Haileybury	September 2	1,500,000
Haliburton Development Company, Limited	Lindsay	February 20	40,000
Hamilton Corundum Company, Limited	Palmer Rapids	January 16	200,000
Hamilton Molybdenum Alloys Company, Limited	Hamilton	December 26	500,000
Homestake Mines Finance Company, Limited	Toronto	April 28	1,000,000
Hunton Gold Mines, Limited	Toronto	July 17	2,500,000
James Cornhill Sons, Limited (Brick)	Chatham	March 3	30,000
Jarvis Oil and Gas Company, Limited	Toronto	January 15	40,000
Kerr-Addison Mines, Limited	Toronto	March 13	2,000,000
Kirkland Lake Development Company, Limited	Toronto	October 27	40,000
Kirkland Lake Gold Mines, Limited	Haileybury	February 25	1,000,000
La Mine D'Or Huronia, Limited	Ottawa	August 15	1,000,000
Lincoln Clay Products, Limited	St. Catharines	July 15	50,000
Maple Sand, Gravel and Brick Company, Limited	Toronto	April 10	100,000
Marten Lake Mining Company, Limited	Gowganda	November 29	2,000,000
Millerton Gold Mines, Limited	Toronto	March 12	3,000,000
Moffat-Irving Steel Works, Limited	Toronto	August 8	100,000
Morse Porcupine Mines, Limited	Toronto	April 14	1,000,000
Mount McKay Products, Limited	Fort William	December 10	600,000
Mountain Lake Silver Mines, Limited	Toronto	April 15	500,000
Napanee Brick and Tile Company, Limited	Napanee	April 28	100,000
National Gas Company, Limited	Toronto	January 25	500,000
New Ontario Pressed Brick Company, Limited	Sudbury	December 15	10,000
Niagara Brick and Tile Company, Limited	Niagara Falls	October 1	100,000
North Star Cobalt Mines, Limited	Toronto	May 8	1,000,000
Northern Building Material and Iron Company, Limited	Sault Ste. Marie	October 21	50,000
Ontario Granite Crushed Stone Company, Limited	Gravenhurst	January 8	60,000
Ontario Steel Products Company, Limited	Gananoque	October 16	1,500,000
Orr Gold Mines, Limited	Toronto	August 20	2,000,000
Pleindor Porcupine Mines, Limited	Toronto	March 7	1,500,000
Porcupine Crown Mines, Limited	Toronto	May 26	2,000,000
Queen City Pressed Brick Company, Limited	Toronto	January 22	200,000
Rideau Silicate Company, Limited	Ottawa	April 22	100,000
Salvator Silver Mine, Limited	Cobalt	March 17	1,000,000
Schaefer Brick Company, Limited	New Hamburg	January 25	75,000
Sharon Mines, Limited	Cobalt	July 2	500,000
Sherrill Porcupine Gold Mines, Limited	Toronto	May 28	1,000,000
Southern Ontario Gas Company, Limited	Hamilton	April 22	400,000

Mining Companies Incorporated in 1913—Continued

Name of Company.	Head Office.	Date of Incorporation	Capital.
Standard Crushed Stone Company, Limited	Niagara Falls	April 7	200.000
Sulphide Chemical Company, Limited	Toronto	May 13	40,000
Superior Sand and Towing Company, Limited	Fort William	February 21	100,000
Sutherland Construction Company, Limited	Toronto	May 29	40,000
Sylvanite Gold Mines, Limited	Haileybury	June 13	2.000,000
Teck-Hughes Gold Mines, Limited	Toronto	April 8	2.000,000
Temagami Chief Mines, Limited	Toronto	March 3	2,500,000
The Alexo Mining Company, Limited	Toronto	January 8	40,000
The Balmy Beach Land and Building Company, Limited	Toronto	April 3	40,000
The Birch Lake Mining Company, Limited	Ottawa	April 24	250,000
The Cameron Island Syndicate, Limited	Hamilton	July 30	200,000
The Century Pressed Brick and Tile Company, Limited	Georgetown	November 11.	250,000
The Champion Brick and Tile Company, Limited	Kingsville	November 18.	75,000
The Cobalt Reduction Company, Limited	Toronto	October 8	350,000
The Credit Valley Stone Company, Limited	Toronto	December 2	250.000
The Crews-McFarlan Mining Company, Limited	North Bay	January 4	3,000.000
The Crow Lake Ironland Company, Limited	Toronto	June 26	100,000
The Dominion Clay Products Company, Limited	Toronto	May 5	150,000
The Electric Steel and Metals Company, Limited	Welland	May 20	500.000
The Flavelle Mining Company, Limited	Toronto	August 14	250,000
The Florica Mining and Milling Company, Limited	Toronto	March 17	400.000
The Gravel, Sand and Crushed Stone Company, Limited	Toronto	May 10	50.000
The Hepworth-Silica Pressed Brick Company, Limited	Hepworth	December 4	125.000
The Independent Natural Gas Company, Limited	Dunnville	March 11	300,000
The International Hematite Company, Limited	Fort Frances	March 3	1.000,000
The Kingsdale Brick Company, Limited	Toronto	February 19.	100.000
The Kohinoor Gold Mines, Limited	Toronto	August 7	2,000.000
The McGrenere Brick and Tile Company, Limited	London	May 13	40,000
The Mikado Consolidated Gold Mines, Limited	Toronto	March 29	2.000,000
The Ontario Stone Corporation, Limited	Toronto	January 30.	75,000
The Ore Extension Mining Company, Limited	Hamilton	November 1	1,500,000
The Point Pelee Sand and Gravel Company, Limited	Point Pelee	June 6	20.000
The Ramsden Sand, Gravel and Brick Company, Limited	Toronto	October 29	100,000
The Renfrew Molybdenum Mines, Limited	Mount St. Patrick	December 8	1.500.000
The Renfrew White Granite Company, Limited	Ottawa	January 25	250,000
The St. Petersburg Graphite Mining Company, Limited	Toronto	July 30	500,000
The Toronto Clay Products, Limited	Toronto	April 23	300,000
The Wallaceburg Gas Company, Limited	Wallaceburg	July 24	200,000
The Wallaceburg Oil Refining Company, Limited	Tp. of Chatham, Wallaceburg P.O.	September 26.	200.000
The Wasabika Mines, Limited	Toronto	July 25	1,000,000
Tough-Oakes Gold Mines, Limited	Haileybury	June 12	3,000,000
Trout Creek Gold Mines, Limited	St. Catharines	January 29	150,000
Vaughan Sand and Gravel Company, Limited	Toronto	December 4	100,000
Wadsworth Lake Mining Company, Limited	Gilmour	May 28	60,000
Wapoose Mines, Limited	Ottawa	May 17	100,000
Waterloo Brick and Tile, Limited	Toronto	May 5	75.000
Windsor Sand and Gravel Company, Limited	Windsor	September 30.	40,000

Mining Companies Licensed in 1913

Name of Company.	Head Office for Ontario.	Date of License.	Capital for use in Ontario.
Algoma Land Company, Limited	Port Arthur	October 1	$100,000
Beacon Oil Company	Chatham	April 26	25,000
British America Nickel Corporation, Limited	Toronto	July 17	20,000,000
Ontario National Brick Company, Limited	Toronto	January 8	1,000,000
T. F. Firth and Sons, Limited	Toronto	March 25	40,000
The Associated Gold Mines of Western Australia, Limited	Almonte	July 24	£15,000
The Federal Stone and Supply Company, Limited	Ottawa	December 23.	$40,000
The Georgian Bay Mining Company, Limited	Windsor	January 20	40,000
The Porcupine Central Development Syndicate, Limited	Toronto	November 7	150,000
Tonkin-Du-Pont Graphite Company	Wilberforce	July 14	125,000
United States Steel Products Company	Toronto	September 22.	40,000
Vermont Marble Company	Peterborough	October 16	100,000

Radium

The Legislature having passed an Act authorizing a bonus to be paid to the discoverer of a workable source of radium (4 Geo. V, chap. 15), it may be of interest to describe the system of measurement used in determining the amount of radium in any material, especially as there has been the greatest confusion in the methods used. In the following notes there is also given a description of the more important radium-bearing materials, an account of the discovery in Germany of a highly radio-active water, and the finding of an interesting source of radium in connection with salt.

Explanation Regarding Units of Measurement used in Connection with Radium

It will be noticed that use is made of the Mache unit in the descriptions given. As there was confusion owing to the fact that different authorities employed different units in measuring radio-activity, an International Radium Standard Commission was appointed to settle the question. The conclusions of this Commission are given in a bulletin issued by the Physikalisch-Technische Reichsanstalt in Berlin. They agreed to accept a preparation of pure radium chloride made by Madame Curie, weighing 21.99 mg. (about one-third of a grain) as the international standard. The emanation from this is measured and from that the emanation that would be given by 1 gram pure radium can be calculated. That is called a curie. This is a very large unit, and accordingly the calculated emanation from a milligram is more frequently used; this is a millicurie. (The equation for converting Mache units into millicuries is 1 millicurie$=2.7\times10^{6}$ Mache units). As the numbers that are dealt with in radio-active measurements are very large, they are written as given above, $10^{6}=1{,}000{,}000$ of course. One millionth would be written 10^{-6}. With very little practice this system of writing will be found to be far the most convenient and therefore is adopted in this description. According to above given equation 1,000 Mache units would equal 3.7×10^{-4} or 37×10^{-5} millicuries. Several of the below mentioned measurements are over 1,000 Mache units. Comparing that with the radio-activity of other waters, Prof. A. S. Eve* gives the radio-activity of the waters of the Caledonia Springs near Ottawa as 15×10^{-9} millicuries. According to Moore and Schlunt, Bull. 395 U. S. Geol. Survey, the most active waters in Yellowstone Park have an activity of about one-quarter that of the Schweizergang Quelle, which was the most active water known in Europe. The strongest water in Yellowstone was equivalent to 268×10^{-8} millicuries per litre. The Schweizergang is therefore equal to a little more than 10^{-5} millicuries per litre, or an activity of 1,000 Mache units is nearly 37 times as strong as the Schweizergang Quelle.

Characters of Radium Ores

A considerable number of uranium-bearing minerals are known, but most of them occur only in small quantities. Among the uranium compounds represented by these minerals are arsenates, carbonates, niobates, oxides, phosphates, silicates and sulphates. However, the ores or minerals from which radium is being extracted at present consist essentially of carnotite, pitchblende and autunite.

The following descriptions of a few of the more important uranium minerals are taken mainly from Dana's System of Mineralogy, 6th edition.

Uraninite. There are several closely related minerals that come under this heading. The mineral to which the name more properly applies contains the oxides of uranium and lead, together with nitrogen, etc. (UO_3, UO_2, PbO, N, etc.). When crystallized the mineral occurs in octahedrons and other forms of the isometric system. It is usually, however, massive or botryoidal (consisting of a group of rounded prominences) and is known as *Pitchblende.*

Uraninite and pitchblende are brittle minerals, with an uneven or conchoidal fracture. The hardness is 5.5, or between that of apatite and orthoclase and less than that of quartz. The specific gravity is comparatively high, being for crystals 9 to 9.7 and for massive altered forms 6.4 or more. The lustre is submetallic to greasy or pitchlike, and dull. The color is greyish, greenish, brownish or velvet-black; streak brownish-black, greyish, or olive-green, a little shining, opaque.

Among the varieties of uraninite may be mentioned, (1) Clevite, which has been found in crystals in the Villeneuve mica mine in Quebec; in addition to the oxides found in uraninite proper, those of the yttrium earths are found in clevite, (2) Bröggerite is similar in composition but contains thorium oxide in addition to the other constituents, (3) Uranniobate is another variety of the mineral that occurs in crystals in coarse granites (pegmatites) in Norway.

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* Trans. Roy. Soc. of Canada, 1910, Vol. IV, Sec. III.

Pitchblende, and the other varieties of uraninite, before the blowpipe, are infusible or only slightly rounded on the edges, sometimes coloring the outer flame green. With borax and salt of phosphorus the minerals give a yellow bead in the oxidizing flame, which becomes green in the reducing. With soda on charcoal they give a coating of lead oxide, and frequently the odor of arsenic. Soluble in nitric and sulphuric acids, the solubility differs widely in different varieties, being greater in those kinds containing the rare earths. Not attracted by the magnet.

The chief characteristics of carnotite and autunite may be summarized as follows:*

Carnotite. Amorphous, perhaps slightly crystalline; pulverulent, in crusts intimately mixed with quartzose sands; color, canary yellow; specific gravity, 4.136; chemical formula, $K_2O.2VO_3.V_2O_5.3H_2O$ (?), uranyl potassium vanadate (?) containing barium and calcium; content of metallic uranium, 52-57 per cent.; found in Colorado, Utah and South Australia.

Autunite. Crystallization, orthorhombic; in plates or tabular crystals, pearly lustre, or in micaceous aggregates; translucent; brittle; cleavage, basal; color, bright yellow; hardness, 2 to 2.5; specific gravity, 3.5 to 3.9; chemical formula, $Ca(VO_2)_2.(PO_4)_2.8H_2O$, uranium and calcium phosphate; content of metallic uranium, 49-50.5 per cent.; found in Connecticut, Massachusetts, Pennsylvania, North Carolina, South Carolina, Utah, France, Madagascar, Portugal, China, Cornwall, Austria and Germany.

It may be added that the silver deposits at Cobalt in their mineral content resemble closely those of Joachimstal, Austria, which have been the most important producers of pitchblende. Practically three generations of minerals are found in the veins at Cobalt, that is minerals have been deposited at three different periods. At Joachimstal, on the other hand, deposition has taken place during five periods, and, unfortunately, the period of deposition which is represented by the pitchblende at Joachimstal is unrepresented at Cobalt. Hence, our deposits have not been found to contain radium-bearing ores.

The radio-active properties of minerals may be detected by the effect they have on photographic plates or by means of the electroscope.

The hydrous mineral, gummite, occurs as a result of the alteration of uraninite. Coracite appears to be uraninite partly altered to gummite. The following note on coracite is taken from the Geology of Canada, 1863, page 504: "An ore of this rare metal (uranium) is said to occur at Maimanse, where it forms a vein about two inches in width, at the junction of the trap and syenite. It was first described in 1847 by Dr. J. L. Leconte as a new ore of uranium under the name of coracite. It is amorphous, pitch-black in color, with a grey streak, a resinous lustre, and a conchoidal fracture. Its hardness is 3.0, and its density 4.38. According to Mr. J. D. Whitney, who subsequently analysed it, it is distinguished from pitchblende by its ready solubility in cold hydrochloric acid, and contains oxyd of uranium 59.30, lime 14.44, oxyd of lead 5.36, oxyd of iron 2.24, alumina 0.90, silica 4.35, carbonic acid 7.47, water 4.64, with traces of magnesia and manganese=98.70. Mr. Whitney, with much probability, suggests that the oxyd of lead, and a portion of the lime, are to be regarded as combined with the sesquioxyd of uranium.

"Uran-ochre, in the form of a sulphur-yellow crystalline crust, has been observed lining fissures in the magnetic iron ore of Madoc," and in Snowdon township, Peterborough county.

Prospectors for radium-holding minerals should pay special attention to those having a pitchy lustre, and to those having a bright yellow oolor and occurring as incrustations or impregnations.

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* Bulletin No. 70, page 92, United States Bureau of Mines.

Discovery of Radio Active Waters

The following paragraph is translated from Jahrbuch für das Berg-und Hüttenwesen im Königreich Sachsen, 1913 (S.B. 175).

Work was energetically carried on in the region of the Marx Semmler adit to discover radio-active water and emanation. In a number of places levels were driven on barren veins belonging to the iron-stone formation; a shaft was sunk under difficult conditions 16 metres under the Marx Semmler adit on the Radium vein, and 91 metres of caved and filled level were drained and space made to set up a diamond drill. Three holes were sunk, with a total length of 353 metres. The results attained can be regarded as satisfactory. The drift off the Marx Semmler adit on the Radium vein was 78 metres long and 38 metres under the surface. At one point along this, 22 litres of water per minute were found with 218 Mache units. Near the end at one spot a very radio-active thread or tiny flow of water was encountered, giving 1.6 litres per minute and showing an activity of 1,440 Mache units. This thread was followed and 2.8 litres of water found with 1,660 Mache units. In October a separation of the rich water was undertaken whereby a quantity of 330 litres with 4,015 Mache units was found. Later on two diamond drill holes were sunk here; the first reached a depth of 117 metres and crosscut as intended stringers of the main vein. Water at the rate of 18 litres per minute with 1033 Mache units was found. The second hole was 85 metres deep and gave 60 litres per minute with 582 Mache units. Then a winze was sunk on the Radium level 26 metres. The mixture of water found in sinking showed an activity of 178 Mache units. From this winze a drift was run 25 metres to pass under the Marx Semmler adit on one of the veins in order to cut off the veinlets of water coming from below which enriched the water of the Marx Semmler adit (giving 300 litres per second) by about 10 Mache units. The workings on the Gleesberg vein, off the Marx Semmler adit, were cleaned out and drained in order to find out where the highly active water which flows out of the adit came from. At a distance of 100 metres this was accomplished and a flow of 40 litres per minute with 185 Mache units was discovered. Another stringer was followed for 27 metres and 2 litres per minute found with 306 units activity. A diamond drill hole was sunk here for 150 metres and disclosed 32 litres of water per minute with 1,180 Mache units.

The work of a number of investigators shows that while radio-activity can be found in all rocks, the eruptive ones show it to a greater extent.

Near the northeast corner of the map by Herman Müller of the Schneeberg district is seen an intrusion of granite. The adit mentioned in above description is also located here. The description of these mines, which were reopened and worked for about forty years, closing in 1893, does not indicate that they were rich in uranium minerals; the only mines where these minerals were obtained are over a mile distant from the place where the very radio-active waters were found. It is curious that this is just where in the olden days the most wonderful specimens and blocks of silver ore were found. It would almost seem as if the radio-activity of the waters in this case was due to radium in the rock and not to radium-bearing minerals in the veins.

In speaking of radio-active waters it should be remembered that the radio-activity may be due either to salts of radium dissolved in the water, in which case the radio-activity will last for years, or it may be due to the radium emanation absorbed by the water; in such cases the activity only lasts a matter of a few days.

Radium Associated with Salt

An interesting source of radium is described by Becker and Holthusen (Ueber absolute Radiumbestimmungen mit dem Emanometer). It appears that in the course of refining the salt at Kreuznach the saline water is caused to trickle through beds of brush to aid evaporation and catch suspended sediment.* From time to time this material is burnt and the ash forms a source of radium. The amount given is

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* Handbuch der Kali-Industrie S. 319. Chem. Technologie.

1.8×10^{-9} gram radium for each gram of ash. This residue, of course, is diluted by the ash from the brush itself. The ash is first treated with dilute hydrochloric acid and a very little sulphuric; this will dissolve the alkaline salts of the ash. The solution is then filtered; all the radium remains in the residue, which is carefully washed. Then it is boiled several times with a concentrated soda solution and treated with a little hydrochloric acid to convert the carbonate into a chloride; then a little sulphuric acid is added and all the radium is precipitated as sulphate. This is less than 5 per cent. of the original ash in amount and may be taken as the starting point. If we multiply 1.8×10^{-9} by 20 we will have approximately the amount of radium in this material. It will give, of course, 3.6×10^{-8} gram radium for each gram of precipitate. To compare this with other sources of radium, according to the paper by H. W. Schmidt and H. Nick (Physik. Zeitschr. XIII, 1912, s. 200), as long as the uranium content of any mineral is known the radium can be calculated according to the following equation, viz.: for each gram uranium metal there is 3.4×10^{-7} radium metal. Now uraninite or pitchblende, the richest uranium mineral, contains about 60 per cent. uranium; therefore, for uraninite the equation would be for each gram pure mineral there is $3.4\times6\times10^{-8}$ radium or practically just six times as much radium as in this precipitate. For carnotite, which is exciting so much interest in Colorado now and of which the shipping ore contains only 2 per cent. of uranium, the equation would be for each unit of ore there are 6.8×10^{-9} units radium or practically five times as much in this precipitate as in the carnotite ore that is shipped.

An analysis of the Kreuznach brine showed it to have the following composition:
Sodium chloride ....=1.42 per cent.
Calcium chloride ....=0.26 per cent.
Magnesium chloride ....=0.02 per cent.
Traces of Bromine and Iodine.

Discovery of Chrome Iron Ore and Diamonds

A few years ago Mr. R. A. A. Johnston, of the Geological Survey of Canada, made the interesting discovery that microscopic diamonds occur in certain chrome iron ore of British Columbia.* Later he found diamonds in similar ore from Quebec province and from other parts of the world.

In March, 1914, the Provincial Geologist, Mr. W. G. Miller, submitted a sample of chromiferous ore or rock to Mr. Johnston for examination for diamonds. A week or so later Mr. Johnston wrote that "the work [of examination of the sample] has only been partially completed, but it has revealed the presence of thousands of microscopic diamonds. These accord in general with the diamonds which I have found under somewhat similar circumstances in other parts of Canada and also in specimens from a number of foreign localities. In their mode of occurrence, however, they differ in one important respect from any which have come under my notice, inasmuch as they may be observed in the silicious portions of the mixture. In one instance this morning we were able to find a distinct octahedron perched on the corner of one of the specimens and as indicated right in the silicious portion."

These Ontario diamonds, while of no apparent economic value, are of course of great scientific interest, especially as they represent the first authentic discovery of diamonds in the Province. The sample examined by Mr. Johnston was sent as a specimen of iron ore to Mr. Miller by Mr. D. O'Connor, who obtained it from his claims in Reaume township, which lies about twenty miles north of Porcupine.

Basic igneous rocks similar to that in which the chrome iron ore and diamonds have been found are somewhat widespread in the areas surrounding Porcupine. The sample examined is very basic and was much decomposed, containing serpentine, some of which evidently represents original phenocrysts of olivine. In some samples from the same locality there are numerous veinlets of asbestus (chrysotile). Associated with the rock in places is pyrrhotite, some of which is nickeliferous. The basic rock at the Alexo nickel mine, in the township of Dundonald, twelve or fifteen miles to the southeast of Reame, apparently belongs to the same series.

The Provincial Assayer, Mr. W. K. McNeill, found the diamondiferous rock to contain 8.46 per cent. of metallic chromium, or 13.44 per cent. of the oxide of chromium, 14.58 per cent. of metallic iron, and .066 oz. of platinum (value about $1.50) to the ton of 2,000 lb.

It is hoped that careful proespecting will lead to the discovery of ore richer in chromium than the sample described. The platinum appears to be readily concentrated, by mechanical means or by fusion, with the chromium. If a workable chromite deposit is discovered the platinum should be recoverable as a by-product.

It has long been known that diamonds occur in the drift or loose deposits in several of the states immediately to the south of the Ontario boundary. This drift, to a large extent, represents material swept off the surface of Ontario by the ice sheet or glaciers and carried southward during the Pleistocene or Glacial period. Hence, it seems reasonable to believe that the home of these diamonds was originally in some part of northern Ontario. If the pipes or necks or dike-like orifices through which the diamondiferous rocks of Reaume and elsewhere ascended towards the surface were discovered, it is possible that larger diamonds might be found, conditions for crystallization having been more favorable.

Platinum, diamonds, even if they are only microscopic, and chromium in one comparatively small specimen make an interesting series. It is hoped that in addition to gold and nickel the Porcupine area will also become a producer of chrome iron ore.

As a producer of nickel and cobalt, Ontario has only one important competitor, New Caledonia, a French penal colony in the southern Pacific. That colony is also one of the world's most important producers of chrome iron ore. Ontario's production has practically killed the cobalt industry in New Caledonia, and the Province's output of nickel now far surpasses that of the French colony. It would be rather remarkable were the Province to enter into competition as a producer of a third mineral.

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* Memoir No. 26, Geol. Sur., Canada.

Although careful search was made in British Columbia for diamonds of economic value, after the discovery of the microscopic specimens, no stones of value have been found. The same may be said of other parts of the world in which microscopic diamonds occur. But there is satisfaction in now being able to say that diamonds do occur in the Province. To the old, often asked question, "Are there diamonds in Ontario?" an affirmative answer can now be given.

Mining Divisions

There were no changes in the Mining Divisions or the Mining Recorders during the year. The list of Divisions and Recorders, together with receipts, follows:—

Mining Division.	Name and P.O. Address of Recorder.	Receipts.				Total Receipts.
		Purchase Money.	Miner's Licenses.	Forest Reserve Permits.	Recording Fees.	
		$	$	$	$	$
Kenora	W. L. Spry, Kenora..............	2,555 50	578 00	....	388 50	3,522 00
Port Arthur	J. W. Morgan, Port Arthur.......	10,250 64	2,250 00	....	3,037 00	15,542 64
Sault St. Marie..	S. T. Bowker, Sault Ste. Marie...	5,502 13	293 00	....	2,480 00	8,275 13
Sudbury	C. A. Campbell, Sudbury..........	2,177 38	4,179 00	270 00	5,621 50	12,247 50
Gowganda	H. E. Sheppard, Gowganda........	3,526 21	1,134 00	210 00	1,033 00	5,903 21
Montreal River ..	A. Skill, Elk Lake	2,932 21	1,030 00	121 00	924 75	5,007 96
Temiskaming....	G. T. Smith, Haileybury..........	6,182 04	9,580 00	100 00	2,491 30	19,353 34
Parry Sound.....	H. F. McQuire, Parry Sound......	162 00	130 00	....	60 00	352 00
Larder Lake	J. A. Hough, Matheson	8,229 58	2,358 00	....	20,535 25	31,122 83
Porcupine........	G. H. Gauthier, Porcupine........	56,653 41	3,935 00	390 00	8,397 00	69,375 41
	Total........................	98,170 10	25,467 00	1,091 00	44,968 30	170,702 02

The Recorders report the work at their offices as follows:—

Kenora

W. L. Spry, Recorder. During the year 45 miner's licenses issued for full year; 11 for part of year; 1 special renewal and 6 ordinary renewals. The small volume of business transacted at this office is an indicator of the lack of activity in mining during the year in this part.

Port Arthur

J. W. Morgan, Recorder, reports 280 miner's licenses issued and 170 renewals, with 182 claims recorded and 379 certificates of full performance of working conditions. The matters which attracted most attention were the discovery of nickel near Big Duck lake, north of Schreiber, and the deposits of hematite south of Shebandowan lake.

Sault Ste. Marie

S. T. Bowker, Recorder. Miner's licenses issued, 108; renewed, 185, with 127 claims recorded.

Sudbury

C. A. Campbell, Recorder. 352 licenses issued and 455 renewals. Total claims recorded, 483, and 442 claims cancelled.

The West Shining Tree district attracted most attention from the prospectors during the year.

Elk Lake

Albert Skill, Recorder. Miner's licenses issued, 45, with 161 renewals and 63 claims recorded. Prospects for activity this season are good.

Gowganda

H. E. Sheppard, Recorder. This office issued 94 licenses and renewed 192. Applications to record claims were 68 and certificates of work 132.

The feature in this division is the success at the Miller Lake-O'Brien mine.

Timiskaming and Coleman

George T. Smith, Recorder. This office issued 590 miner's licenses and 1,326 renewals. There were 265 applications to record claims.

Larder Lake

J. A. Hough, Recorder. Total number of licenses issued and renewed was 492, and 1,575 applications to record.

The Kirkland Lake district accounts for the activity in this mining division. There was also a stir in townships of Munro, Beatty and Maisonville.

Parry Sound

H. F. McQuire, Recorder. Only 43 licenses were issued by this office. Work was done on a few iron claims.

Porcupine

G. H. Gauthier, Recorder, reports 191 miner's licenses issued and 643 renewals. Number of claims recorded, 496.

Provincial Assay Office

Mr. W. K. McNeill, B.Sc., Provincial Assayer, reports as follows for the year 1913:

The Provincial Assay Office was established at Belleville, Ont., in 1898, as an aid, in a practical manner, in the development of the mineral resources of the Province, this object being attained by the sampling and assaying of ores and rocks for the prospectors and others at a reasonable fee, by the analysis of rocks, etc., for the geologists of the Bureau of Mines and by original research along lines suggested by the officers of the Bureau.

In November, 1911, the laboratories were removed from Belleville to Toronto, Ont., and established at No. 5 Queen's Park, as the pressing need for larger accommodation was recognized. By the results since obtained it has been found that the present location is much more central and convenient for the Bureau of Mines as well as the public.

The Chemical Laboratories and Assay Office are among the most up-to-date in the Province, and are especially designed and equipped for accurate work; but so as not to encroach on the professional domain of private assayers and testing laboratories, a fee is charged for all public work, the purpose being to have a laboratory to assist prospectors and do umpire work.

The work consists of:

(*a*) Examination and assaying of samples received from prospectors, mining engineers, geologists and the public generally.

(*b*) Analysis of samples of rocks, etc., for the geologists of the Bureau of Mines.

(*c*) The sampling of carload lots of cobalt silver ores shipped from the mines, upon which the Government collects a royalty. This work is done at the various smelters and is in charge of Mr. T. E. Rothwell, Assistant Assayer.

(*d*) The assaying and valuation of these car lots.

(*e*) Special research work.

During the year just closed the work has been naturally much along the lines of former years. Notwithstanding the fact that no new fields were opened up, a large number of gold and silver samples passed through the office and during the year it was noted that there was an increasingly larger number of samples sent in from all parts of the Province for identification. By the enquiries received concerning clays, pyrites, etc., it would appear that the public interest is not confined to the more precious metals, but work is being carried on in all branches of the industry. The specimens examined may be more conveniently arranged as follows:

Assays for Gold and Silver.—During the year two hundred and seventy-seven samples were examined for the public and one hundred and fifty samples for the Bureau, which include car lots, each lot being represented in the report as one sample.

Iron Ores.—During the year thirteen samples of ore were examined and reported upon. These were analyzed for silica, iron, sulphur and phosphorus and in some cases titanium.

Copper Ores.—Copper content of fourteen ores were determined.

Nickel Ores.—Thirteen samples were reported upon during the year and a large number were sent in for identification.

Cobalt Ores.—The work here was entirely on the estimation of the cobalt oxide in the shipments from the different mines.

Rocks and Limestones.—Altogether fifty-one samples were examined—forty-three for the Bureau and eight for the public.

Miscellaneous.—Under this head are included identifications analysis of molybdenite, tin ore, potash-bearing rocks, clays, supposedly platinum-bearing sands, infusorial earths, corundum and chromium ores. In addition, information was given regarding the value of ores, rocks, etc.; also methods of development. Some original research was carried on under instruction from the Provincial Geologist, the results of which will be published separately.

The following is the new schedule of fees which is now in operation. Copies may be obtained by applying to the Provincial Assayer, No. 5 Queen's Park, Toronto, Ont.

Schedule of Charges

Samples will be dealt with in the order of their arrival. In every instance specimens and samples should be accompanied by statements specifying the precise locality from whence they were taken.

Directions.—Crushed samples representing large quantities or samples less than five pounds weight may be sent by mail as third class mail matter. Write your name and address plainly on each parcel. Send instructions, with money in payment of fees, in a separate letter. Samples may be sent by express, charges prepaid.

Sample bags addressed to this laboratory for sending ore pulp by mail may be obtained free on application; also, canvas bags for shipping.

Terms.—Money in payment of fees, sent in by registered letter, postoffice order, postal note, or express order, and made payable to the Provincial Assayer, must invariably accompany sample to insure prompt return of certificate, as no examination is commenced until the regulation fee is paid.

Samples addressed as follows:

To
Provincial Assay Office,
5 Queen's Park,
Toronto, Ont.

Tariff of Fees for Analyses and Assays

1. Assays:	
Gold	$1 00
Silver	1 00
Gold and Silver in one sample	1 50
Platinum	4 00
Gold and Platinum in one sample	5 00
Gold by amalgamation	2 00
For the amalgamation assay for gold at least five pounds of ore must be sent.	
2. Iron Ores:	
Iron (metallic)	$1 00
Silica	1 50
Iron and insoluble residue	1 50
Ferrous Oxide	2 00
Phosphorus	2 00
Sulphur	2 00
Iron, Sulphur, Phosphorus and insoluble	5 00

Manganese	2 00
Titanium	2 00
Complete analysis: Ferrous Oxide, Ferric Oxide, Total, Metallic Iron, Silica, Alumina, Lime, Magnesia, Manganese, Phosphorus, Sulphur and Titanium	15 00

3. Limestones, Dolomites, Marls, Clays, Shales:—
Determination of:

Insolubles	$1 00
Silica	1 50
Ferric Iron	2 00
Ferrous Iron	2 00
Alumina	2 00
Lime	1 50
Magnesia	1 50
Alkalies (combined)	5 00
Potash	4 00
Water (combined)	1 00
Moisture	0 50
Organic matter	1 00
Carbon Dioxide	1 50
Phosphorus Anhydride	2 00
Sulphur	2 00

4. Examination of Clay, Shale or Cement Rock for cement manufacture.
Determination of:

Silica, Iron Oxide, Alumina, Lime, Magnesia, Sulphuric Anhydride and Volatile Matter	$10 00

5. Coal, Coke, Peat, etc.:
Determination of:

Moisture	$0 50
Volatile combustible	1 00
Fixed carbon	1 00
Ash	1 00
Sulphur	2 00
Phosphorus	2 00
Calorific value	5 00
Ultimate analysis	Price on application

6. Mineral waters	Price on application

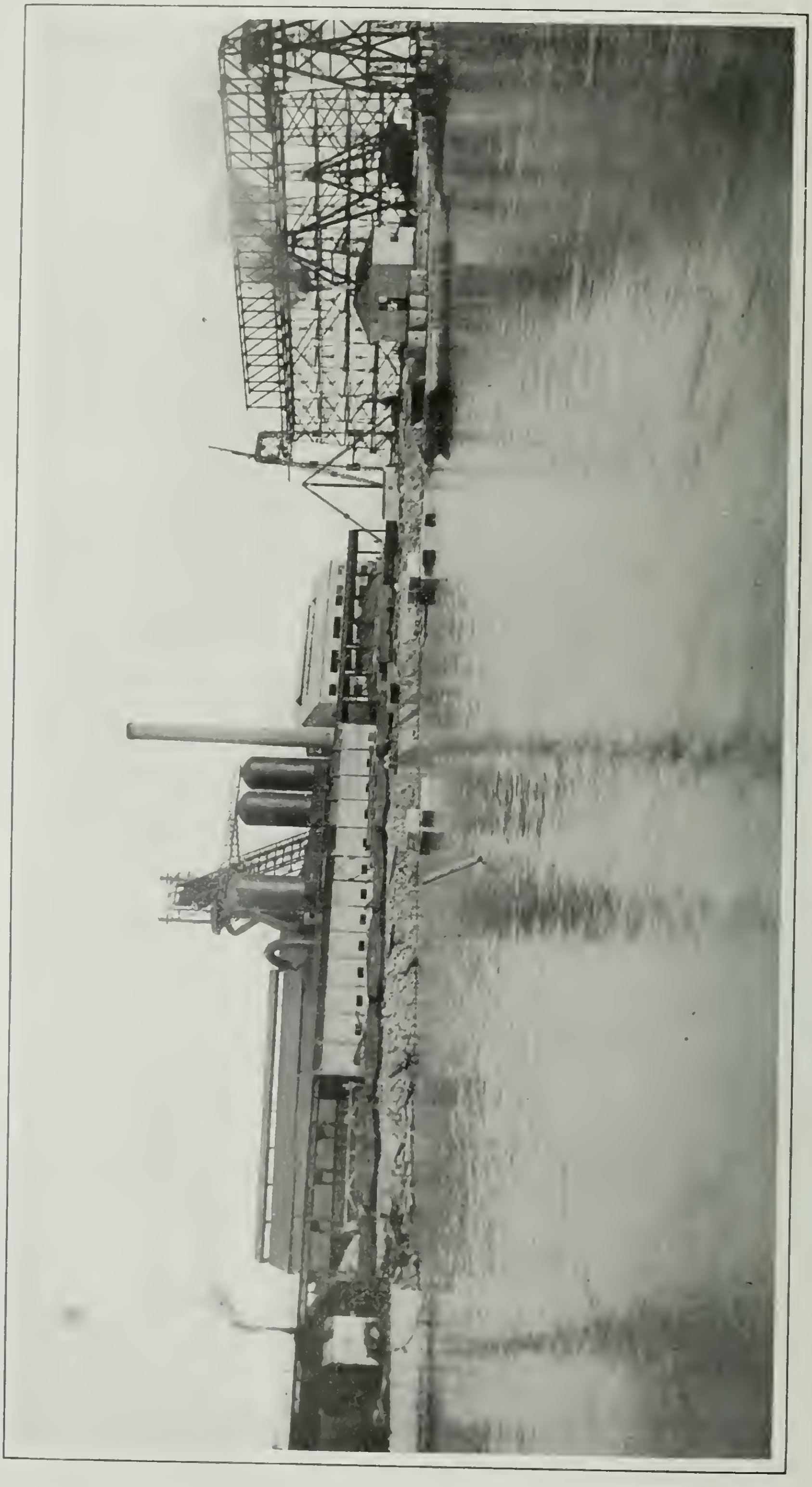
7. Ores and Minerals:
Determination of:

Alumina	$2 00
Antimony	3 00
Arsenic	3 00
Bismuth	3 00
Cadmium	3 00
Chromium	3 00
Cobalt	3 00
Copper	2 00
Gold	1 00
Ferrous Oxide	2 00
Ferric Oxide	2 00
Lead	2 00
Lime	1 50
Magnesia	1 50
Molybdenum	2 00
Manganese	2 00
Nickel	3 00
Silica	1 50
Water	1 00
Zinc	2 00

8. Rocks, complete analysis	Price on application
9. Slags, Sands, etc.	Price on application
10. Identification of minerals and rocks not requiring chemical analysis	Free

Any chemical work not specified in this circular will be undertaken on application to the Provincial Assayer.

The pulp of each sample is retained for future reference.



Port Colborne Plant of the Canadian Furnace Company, Limited.

MINING ACCIDENTS IN ONTARIO IN 1913

By T. F. SUTHERLAND, Chief Inspector of Mines

During the year 1913 in and about the mines, metallurgical works and quarries regulated by the Mining Act of Ontario, there were 57 fatal accidents, causing the death of 64 men. Of these fatal accidents 32, causing the death of 37 men, occurred underground; 7, causing the death of 8 men, on the surface; 11, causing the death of 11 men, at metallurgical works; 7, causing the death of 8 men, at quarries. The tables of accidents at the metallurgical works and quarries are separated in this Report from accidents at the mines.

The total number of serious accidents in and about the mines of Ontario reported to the Bureau of Mines in 1913, was 353, resulting in 45 persons killed and 320 injured; of these accidents 284 occurred underground, and 69 above. The fatal accidents took place in mines operated by 19 different companies, the same number as in 1912.

At metallurgical works there were 212 accidents which caused the death of 11 and serious injuries to 201 men.

At quarries there were 18 accidents which caused the death of 8, and serious injuries to 12 men. It is evident that all the non-fatal accidents at quarries are not reported to this Department.

In accordance with the Mining Act inquests were held on all fatal accidents and attended by one of the Inspectors.

The following table shows that on an average 2 men received serious injuries in the mining industry on nearly every working day of 1913.

Table of Accidents

—	1912.		1913.	
	Killed.	Injured.	Killed.	Injured.
Mines:—				
No. killed underground	26	....	37	....
No. " surface	6	....	8	....
No. injured underground	....	160	....	251
No. " surface	....	56	....	69
Metallurgical Works:—				
No. killed	10	....	11	....
No. injured	....	122	....	201
Quarries:—				
No. killed	1	....	8	....
No. injured	....	3	....	12
Totals	43	341	64	533

The following classification distributes the responsibility for the cause of the fatalities:

	Per cent.
1. Fatalities due to danger inherent to the work itself	19, or 29.7
2. " arising out of defects in mine workings	16, or 25.
3. " due to fault of fellow workman	3, or 4.7
4. " due to fault of workman himself	26, or 40.6

By months, the 64 fatalities occurred as follows:—

January, 10; February, 12; March, 9; April, 6; May, 8; June, 2; July, 5; August, 6; September, 1; October, 2; November, 2; December, 1; Total 64.

During the first six months of the year, 47 men were killed, compared with 17 during the latter six months.

Analysis of Fatalities at Mines

A comparison of the causes of the fatalities at the mines for 1912 and 1913 is as follows:

Cause.	1912	1913
	Per cent.	Per cent.
Falls of ground	9.4	11.1
Shaft accidents	25.0	20.0
Explosives	21.9	31.1
Miscellaneous (underground)	25.0	20.0
Surface	18.7	17.8

While it is to be hoped that the number of deaths from accidents is abnormal for the year 1913, yet it will be seen that a large number are the result of want of proper care on the part of the workman and those in charge, and also a lack of proper appreciation of the risks inherent to the nature of the industry.

Sixty-five per cent. of the fatal accidents during the year could have been avoided by the exercise of greater caution on the part of the workmen, and by the mine operators insisting on a strict enforcement of the Mining Act. There are several mines in Cobalt which have a good record, especially during the past two years. These mines must necessarily employ the same class of labor as adjoining properties, yet their accident rate is much lower than the average of the camp.

An example of what can be accomplished in accident prevention by intelligent effort is furnished by the Canadian Copper Company, at Copper Cliff. Mr. E. T. Corkill, formerly Chief Inspector of Mines for the Province of Ontario, was appointed Safety Engineer for this company on July 1st, 1913. The accident lists published in this report show that for the first six months of 1913, this company had 11 men killed; for the last six months, 3. Of serious accidents which incapacitated the workmen for over five weeks, the first six months shows 40 men, and the last six months, 17. A corresponding decrease is noticed in the minor accidents.

To decrease the accidents requires as honest an effort as to decrease the costs, or to increase the production. To issue general rules without seeing that these rules are observed may be a protection in damage suits, but will not diminish the number of accidents.

Table of Fatal Accidents in Mines, Metallurgical Works and Quarries, 1901 to 1913

—	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	Total.
Persons killed at Metallurgical Works and Mines	13	10	7	7	9	11	22	47	49	48	49	43	64	379
Persons employed at Metallurgical Works and producing mines	4,135	4,426	3,499	3,475	4,415	5,017	6,305	7,435	8,505	10,862	12,543	13,108	14,293	97.918
Persons employed at non producing mines (estimated)	550	450	400	400	500	750	1,140	1.750	2,000	2.000	2,000	2,000	2,000	15,940
Total persons employed	4,685	4,876	3,899	3,875	4,915	5,767	7.345	9.185	10,505	12,862	14,543	15,108	16,293	113.858
Fatal accidents per 1,000 employed	2.77	2.05	1.79	1.80	1.83	1.90	2.99	5.11	4.66	3.73	3.37	2.84	3.93	3.34

Cause and Place of Fatalities in Mines

The following schedule shows the cause and place of the fatalities in 1913 compared with 1912:—

	1913.	1912.
Below ground:—		
Falls of grounds	5	3
Shaft accidents:—		
Falling down shaft	1	4
Objects falling down shaft	2	2
Falling from bucket	0	1
Attempting to get on or off skip or cage in motion	4	1
Falling cross-head	2	0
	— 9	— 8
Explosive accidents:—		
Premature explosion while loading or lighting holes	8	0
Drilling into bottom of old or missed holes	5	1
Asphyxiation from gases from explosives	1	5
Picking or putting bar into old hole containing explosive	0	1
	—14	— 7
Miscellaneous accidents:—		
Falling down winze	1	3
Falling down stope	1	2
Struck or buried by ore	4	2
Struck by bar while barring ore from chute	0	1
Struck by falling objects	2	0
Crushed between cars	1	0
	— 9	— 8
Above ground:—		
Blowing up of thawing house	0	1
Struck by falling objects	0	2
Electrocuted	2	1
Killed by fall	3	1
Burned	0	1
Caught by machinery	2	0
Crushed by car	1	0
	— 8	— 6
Total	—45	—32

The occupation and nationality of men killed in or about the mines are set out in the following table:

Occupation.	English Speaking.	Finn.	Italian.	Pole.	Swede.	Austrian.	French.	Total.
Deck hand	......	......	......	1	......	......	......	1
Oiler	1	......	......	......	......	......	......	1
Lamp tender	......	......	1	......	......	......	......	1
Drill runner	5	3	2	1	1	2	......	14
Trammer	3	......	2	4	......	3	......	12
Drill helper	2	1	1	......	......	1	......	5
Laborer	1	......	......	......	......	......	......	1
Skip tender	1	......	......	1	......	......	......	2
Carpenter	2	......	......	......	......	......	......	2
Chute tender	......	1	......	......	......	......	......	1
Powderman	1	......	......	1	......	......	......	2
Pipe fitter	......	1	......	......	......	......	......	1
Electrician	1	......	......	......	......	......	......	1
Mill man	......	......	......	......	......	......	1	1
Totals	17	6	6	8	1	6	1	45

The ages of the men killed at the mines were as follows:—

17–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	Total.
3	11	15	11	4	....	....	....	....	1	45

Cause and Place of Non-Fatal Accidents at Mines

The following schedule shows the cause and place of the non-fatal accidents in 1913 at the mines and the number injured:—

Underground:—		
Falls of ground	9	
Shaft accidents:—		
Cage accidents	9	
Falling part way down shaft	7	
Objects falling down shaft	6	
Miscellaneous	3	
		25
Explosives:—		
Drilling into old or missed holes	6	
Picking into explosives	4	
Premature explosion	6	
		16

Miscellaneous accidents:—		
Falling down stopes, raises, winzes, chutes or man-ways	23	
Jammed by cars, skips, buckets or pieces of rock or ore	60	
Scaling	19	
Foreign material in eyes	2	
Injured at chutes	24	
Burned	5	
Flying rock	4	
Rock rolling down pile	20	
Caught by drill	18	
Falling objects	15	
Miscellaneous	18	
		208
Surface:—		
Falling from elevated places	12	
Caught by machinery	12	
Burned by electric wire	1	
Falling objects	14	
Burned	1	
Miscellaneous	22	
		62
Totals		320

The occupation and nationality of the men injured in or about the mines were as given below:—

Occupation.	English Speaking.	Italian.	Pole.	Finn.	Russian.	Austrian.	Roumanian.	Spanish.	Syrian.	German	Bulgarian.	Swede.	Nationality Unknown.	Total.
Hoistman	....	....	....	....	....	....	....	....	....	....	....	....	1	1
Mill Man	8	1	....	....	....	....	....	....	....	....	....	....	....	9
Drill Runner	28	9	7	34	....	....	....	....	....	....	....	1	....	79
Trammer	3	21	35	12	4	11	1	4	....	....	2	....	1	94
Laborer	3	8	6	2	....	....	....	....	1	....	....	....	....	20
Pumpman	1	....	....	1	....	....	....	....	....	....	....	....	....	2
Drill Helper	9	2	6	17	1	1	1	....	....	1	....	....	....	38
Carpenter	4	1	....	....	....	....	....	....	....	....	....	....	....	5
Timberman	6	....	....	2	1	....	....	....	....	1	....	1	....	11
Nipper	1	....	....	....	1	1	....	....	....	....	....	....	....	3
Foreman	13	2	....	....	....	....	....	....	....	....	....	....	....	15
Machinist	6	....	....	....	1	....	....	....	....	....	....	....	....	7
Cage Tender	....	2	3	1	....	1	....	....	....	....	....	....	....	7
Teamster	2	....	1	....	....	....	....	....	....	....	....	....	....	3
Pipe Fitter	2	....	....	....	....	....	....	....	....	....	....	....	....	2
Ore Sorter	1	....	1	....	....	....	....	....	....	....	....	....	....	2
Crusher Man	1	1	1	....	1	2	....	....	....	....	....	....	....	6
Painter	....	1	....	....	....	....	....	....	....	....	....	....	....	1
Blacksmith	1	1	....	....	....	....	....	....	....	....	....	....	....	2
Blacksmith's Helper	....	1	1	....	....	....	....	....	....	....	....	....	....	2
Engineer	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Scaler	....	....	....	2	....	....	....	....	....	....	....	....	....	2
Chute Tender	....	....	3	2	....	....	....	....	....	....	....	....	....	5
Deck Man	....	....	....	....	1	....	....	....	....	....	....	....	....	1
Electrician	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Surveyor	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Totals	92	50	64	73	10	16	2	4	1	2	2	2	2	320

The ages of the men injured at the mines were as follows:—

17–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	Unknown	Total
16	115	76	43	25	11	8	1	0	0	25	320

The following table shows the time during which the injured persons were incapacitated for work.

Class of Work	1 to 2 Weeks	2 to 3 Weeks	3 to 4 Weeks	4 to 5 Weeks	5 to 6 Weeks	6 to 7 Weeks	7 to 8 Weeks	8 to 9 Weeks	9 to 10 Weeks	10 to 12 Weeks	Over 12 Weeks	Permanent	Not Reported Cured	Totals
Mines—														
Above ground	24	13	5	3	4	2	1	2	2	1	1	0	2	60
Below ground	85	40	35	20	11	7	7	7	2	8	11	7	20	260
Metallurgical Works.....	99	34	14	7	9	3	4	4	3	4	6	1	13	201
Quarries................	1	4	....	....	1	1	1	....	....	....	....	....	4	12
Totals	209	91	54	30	25	13	13	13	7	13	18	8	39	533

Mining Regulations and How Observed

The investigations by this Department into many of the accidents during the past year show a non-observance of the Mining Act by some operators and many employees, and emphasize forcibly the need of further Government supervision. The Mining Act is wide in its requirements, and penalties are provided for non-observance. Infringements have to be proven in court on information laid by the Inspector. The policy so far followed has been to take action only in flagrant cases where life has been endangered. Thus, it is only after an accident has happened that a prosecution follows. The result has been that, in several instances, mine operators have taken chances with dangerous conditions, trusting that they could get through without an accident and have the work completed before an Inspector visited them. The men under ground handle powder carelessly, drill into old bottoms, and follow other dangerous practices, knowing that, if caught by the foreman, the worst that will happen is to be discharged, and they know that they can go to the next mine and obtain employment. Foremen rarely report an infringement of the Mining Act to the Inspector. The result is that careless and reckless workmen drift from mine to mine, endangering their own safety and that of their fellow workmen.

If only licensed men were allowed to be in charge of actual mining operations, and if the holding of such a license depended upon the safety of the mining methods followed, it would tend to decrease the high accident rate of the mines of Ontario.

Falls of Ground

Five men were killed during 1913 as a result of falls of ground, an increase of two over the preceding year. In addition, two men were so seriously injured that a fatal termination of the accident is expected during the present year.

At the Garson mine on January 14th a sledger in No. 33 stope was killed while helping to take down some bad ground. He thought he was standing at a safe distance.

At the Henderson talc mine, near Madoc, operated by Cross and Wellington, on March 17th a large block of talc fell, carrying out the timbers and injuring three men, two of whom died from the injuries received. One of the men killed had noticed some small pieces of talc falling about ten minutes before the big fall, but, being inexperienced, did not realize the danger or act on the warning given.

At the Temiskaming mine on March 25th a fall of ground occurred between the 200- and 300-foot levels, carrying out the timbers at the cross-cut chute, No. 1 vein, and killing a trammer who was loading his car at this chute.

At the Creighton mine on December 9th the brow of the open pit on the north side slipped into the open pit, carrying with it the pillars, and crushing the dry walls on the fifth level. One man was killed; one had his back broken; one sustained a fractured skull; one had his leg broken; several others received minor injuries. The fall was due to a slip about 40 feet back from the brow, which dipped into the pit about 250 feet below the surface. Approximately 230,000 tons of rock fell.

This accident shows the necessity for removing the overburden around such pits in order to detect any slips or fissures.

At the Northern Pyrites mine on November 6th a Finnish drill helper was injured, receiving a direct concussion of the spine, with paralysis of lower extremities, through being struck by a slab of ore which was being drilled in order to be blasted down. Attempts to take down this slab with scaling bars had been unsuccessful. The injured man thought he was at a safe distance from the slab if it fell.

The latest hospital reports indicate that the injured man has no chance of recovery, althougth he may live for a considerable time.

Shaft and Winze Accidents

Ten men were killed during the past year in shaft and winze accidents, a decrease of one compared with the preceding year.

Seven of these accidents were the result of a direct infringement of the Mining Act—two on the part of the company, four on the part of the men killed and one on the part of a fellow workman.

On January 8th an employee of the Right of Way Mining Company was killed by a falling crosshead. This crosshead was not equipped with a safety device, and the company was fined $250 and costs.

On February 22nd an employee of the Canadian Gold and Silver Mining Company was killed by a falling crosshead which was not equipped with a safety device.

At the inquest held in connection with this accident the jury brought in a verdict charging the management with criminal negligence. The manager was arrested, and the case was subsequently dismissed by the magistrate on account of the jury naming the management. It was held that the manager could not be considered the management.

On January 5th an employee of the Canadian Copper Company was killed at the Creighton mine while stealing a ride on the skip.

On October 28th at the same mine an employee was sent up in the timber skip with an injured workman. Evidently considering that the injured man was capable of looking after himself, and not wanting to climb down the ladders, he attempted to jump off the moving skip at the fourth level and was killed.

On July 14th at the Long Lake gold mine a skip tender jumped on the skip to save a climb of fifteen feet. He was caught against the timber and instantly killed.

On February 18th at the Cobalt Lake mine, while the men were being sent to the surface, a Pole was killed while attempting to board the cage after the hoisting signal had been given.

On January 15th at the Fourth of July shaft of the Nipissing Mining Company, while the cage tender was unloading steel at the first level, a Finnish drill runner on the second level rang the hoisting signal. The cage tender was caught by a steel and killed.

The above accidents were all caused by non-compliance with the Mining Act.

On January 20th at the Frood Extension mine of the Mond Nickel Company, a cleat used to support the door at the collar of the shaft was jarred loose and fell, killing a workman at the bottom of the shaft.

On August 29th at the same mine while a bucket of rock was being hoisted the cable broke, and the falling bucket killed a workman in the shaft.

On February 16th, while timbering in a winze from the Meyers shaft of the Nipissing Mining Company, a corner of the staging became loosened, allowing a workman to fall a distance of twenty-five feet. He sustained a fracture of the base of the skull which resulted fatally twelve hours later. The presence of a chain ladder in the winze saved a fellow workman from injury.

Several accidents during the past year were due to an inferior type of cage. The man-cages used by the Inland Steel Company must be constructed according to the following description:—

Cages

" Bonnet shall be made of steel plate, 3-16-inch in thickness, sloping toward each side and so arranged that it may be readily pushed upward to afford egress to persons therein, and such bonnet must cover the top of the cage in such a manner as to protect those on the cage from objects falling in the shaft. The cage will be provided with sheet iron or steel side casing, not less than ⅛ inch thick, or with a netting composed of wire not less than ⅛ inch in diameter, and with doors made of suitable material. These doors shall extend at least five feet above the bottom of the cage and must be closed when lowering or hoisting men, except timbermen riding on the cage to attend to timbers that are being lowered or hoisted. Every cage must have overhead bars of such arrangement as to give every man on the cage an easy and secure handhold. Every cage or skip used for hoisting men must be provided with a safety catch of sufficient strength to hold the cage or skip with its maximum load at any point in the shaft in the event that the hoisting cable should break."

Accidents from Explosives

During the year 1913 sixteen men were killed in accidents due to the use of explosives, as against seven fatalities in 1912 and sixteen in 1911. This represents 25 per cent. of the total number of fatalities in and around the mines, metallurgical works and quarries in the Province of Ontario.

Of the fatalities under ground 38 per cent. were due to explosives. In addition five men were totally blinded, two men had the sight of both eyes partially destroyed, one man had his hand blown off, and two men had three fingers blown off; altogether 47 men were killed and injured in 31 accidents occurring at 25 different mines and quarries.

An analysis of these accidents shows a deplorable recklessness and lack of knowledge on the part of the workmen in the handling of explosives. Of the 31 accidents, resulting in the death of 16 men and the total disability of 5 others, probably only 7, resulting in one fatality, can be said to have been unavoidable.

At the Hudson Bay mine, Gowganda, two miners, using hand steel, deliberately cleaned out an old hole and started drilling in it. Evidently the hole was partly filled with small pieces of rock, as, after drilling about two minutes, an explosion occurred, which killed both men and injured a trammer who was working near them.

At the North Dome mine, Porcupine, a drill runner started a hole within three inches of the collar of an old hole, but lined up his machine so that it ran into the old hole about eighteen inches from the collar. The helper was killed and the drill runner lost the sight of both eyes.

At the Cobalt Townsite mine a hammer-drill runner was killed while loading back holes. From the nature of his injuries it is surmised that he allowed the flame of his carbide lamp to strike the powder while examining a cut-off hole.

Two men were killed while loading a 20-foot hole with gelignite at the Intercities Quarry, Port Arthur. The probable explanation is that they were ramming the explosive too hard.

At the Hudson Bay mine, Cobalt, one man was killed and one totally blinded by drilling into a cut-off hole. It was known that there was one report short from the previous round. In this case, owing to a slip, it would have been hard to detect the cut-off hole, but there was plenty of room to drill a hole in such a position that there would not be any possibility of its intersecting the cut-off hole.

At Moose Mountain a drill runner was taking up a section of the floor of the open pit so that a track could be laid. While drilling a pop hole an explosion occurred which killed him. The maps and records of the company showed that it was in 1910 that this particular part of the mine had been worked out.

At the Hollinger mine two men, while lighting a round of holes, received injuries which resulted fatally. At the inquest the jury brought in a verdict that the premature explosion was due to a quick fuse.

At the property of the Dane Copper Company two men lost the sight of both eyes through an explosion caused by drilling into a cut-off hole. Johnson, drill runner, had taken a contract for the underground work and was squaring up the face in one of the drifts. It was his first underground work at this property.

At the Coniagas mine two men were killed while preparing to load a round of holes. There was no evidence to show the cause of the explosion. This is the first fatal accident at the Coniagas mine, which has been operated continuously since 1904.

At the Hollinger Reserve mine two men were killed while preparing to refire some missed holes. An investigation of this accident indicated that the men were attempting to remove the tamping from one of the holes with an iron scraper.

At the Magpie mine a drill runner was attempting to fire a round in a raise with a battery. Being unable to get an explosion, he disconnected the battery, wound the wires round the air line, and climbed up in the raise to see if the connections were at fault. Lightning struck the surface plant, followed the air line under ground and exploded the holes. The man was instantly killed.

At the Cobalt Lake mine, while examining a cut-off hole, one man was totally blinded and one had the sight of both eyes partially destroyed. The rock at the collar of the hole was shattered and the explosion occurred while the drill runner was removing some of this rock with his hands. It was the first shift for both men at this mine.

Two accidents occurred while block-holing; the block being drilled contained a cut-off hole.

Three accidents resulted from men not seeking shelter when the blasters were sand-blasting. In each case sufficient warning was given.

Two accidents were the result of striking powder or detonators in the broken ore.

At the North Dome mine a miner was refiring a round when he was overcome with gas. The evidence at the inquest showed that he had succeeded in lighting the holes and was back from the face about eighteen feet when overcome. About half an hour after the explosion he was taken to the surface, but died shortly afterwards.

Two accidents resulted from curiosity regarding detonators. One man held a lighted cigarette against a detonator; another found a short piece of fuse with a detonator attached in the broken ore. He lighted the fuse and held it. In both cases three fingers were blown off.

The following rules to be observed in the handling of explosives are taken from the Rule Book of the Nipissing Mining Company, Limited. This Rule Book is published in English, French and Finnish.

Explosives

Extracts from the Mines Act of Ontario:

"Cases containing explosives shall not be opened in the magazine and only implements of wood, brass or copper shall be used in opening the cases.

"Any employee who commits a careless act with an explosive, or where explosives are stored, or who, having discovered it, omits or neglects to report immediately such act to an officer in charge of the mine, shall be guilty of an offence against this Act, and the officer in charge of the mine shall immediately report such offence to the Inspector or to the Crown Attorney of the County or District in which the mine is situate.

"In charging holes for blasting, no iron or steel tool or rod shall be used, and no iron or steel shall be used in any hole containing explosives, and no drilling shall be done in any hole that has been blasted, nor shall any iron or steel tool be introduced into the bottom of any such hole.

"When a miner fires a round of holes he shall count the number of shots exploding, except in case of instantaneous blasting by electricity. If there are any reports missing he shall report the same to the mine captain or shift boss. If a missed hole has not been fired at the end of a shift, that fact, together with the position of the hole shall be reported by the mine captain or shift boss to the mine captain or the shift boss in charge of the next relay of miners, before work is commenced.

"A charge which has missed fire shall not be withdrawn, but shall be blasted, and no drilling shall be done in the working place where there is a missed hole or a cut-off hole containing explosive until it has been blasted."

All blasting powders do best work and give off least gas and smoke when they are thoroughly thawed.

Never thaw powder near a fire of any kind, or in hot water or steam. Always thaw through some medium of radiation, never by direct heat or contact.

Never use frozen or chilled powder.

Never use powder that shows white crystals on the wrapper.

Never use an ore sack for carrying powder. Use nothing but the regular powder bag.

Never put caps and fuse in a powder bag.

Never put unused or scraps of powder in boot-legs or on shelves of rock. Put it directly into the waste powder box provided for that purpose.

Never keep explosives in a damp place before loading.

Never take your powder underground until you are ready to use it. Plan your work so that you fire a charge as soon as it is loaded. Powder which is put into holes too soon and allowed to stand becomes chilled and the breaking power is reduced. Chilled powder may not entirely explode and there is then danger of the unexploded powder getting mixed with the broken rock.

Never force powder into a tight or caving hole.

Never reload a hot hole, either from burning or from springing. Give it plenty of time to cool.

Never lace a fuse through a stick of powder. This may crack the fuse and make a miss fire or a burnt hole. All primers must be punched with a WOODEN PIN and the cap inserted ONLY in the END and made fast by tying with string.

Never place your primer anywhere but on top of the last stick in the hole.

Never blast until you are sure that every entrance to the face being blasted is guarded. Never blast until you have thoroughly arranged with others working near you, at what time you will blast and which direction you will take when going out.

Never light a fuse until the charge has been thoroughly tamped. Tamping gives the powder a better chance to break, providing the hole itself has been solidly filled with powder. Tamping may prevent a premature explosion, sometimes caused by fuse powder falling into an un-tamped hole.

Never use a dynamite paper torch or carbide lamp for lighting fuse. Always use notched-fuse spitter.

Never spit fuse until you have examined all ladders and run-ways and are sure they are in proper condition. Always have more than one light when spitting.

Never, from first to last, let your light come near powder. Be sure your light is not hanging directly over powder or caps. Keep it to one side.

Never get careless with powder. It is manufactured to explode under certain conditions, and if you give it any chance at all, it is going to do exactly what it was made for. Keep it away from shock, sudden changes of temperature, fire, etc.

When sinking, all firing must be done by electric current.

When using lighting current, be sure all switches have been thrown out and properly guarded before commencing to connect your wires.

Never take a chance on firing a battery round when there is an electrical storm.

Caps

In order to set off dynamite properly, it is necessary to give it a strong, sharp shock. Caps are made and used for that purpose. That being the case, it is only common sense to keep powder and caps away from each other until the final preparation has been made. Caps are more sensitive to shock than powder. Use in greater degree the same precautions necessary with powder.

Fuse

Always keep fuse in a cool, dry place. Before loading a hole, run the fuse through your fingers, in order to detect if possible, any cracks or thin or swollen places. Any of these may cause a quick fuse or miss-fire. Never use any fuse that is not regular in size, or that looks cracked or bad in any way.

When spitting a round of holes, always look for signs of a quick fuse. Keep this in mind all the time. If there are two or more men in the face, one of them should continually watch while the other is busy spitting.

Never carry fuse and caps around your hat brim.

Report to the Captain immediately anything about Powder, Fuse and Caps, which you have reason to believe may be faulty.

The following table of accidents from the use of explosives gives the nature and cause of accident and the explosive used:—

Accidents resulting from the

No.	Date	Number injured.	Name of Mine.	Explosive used.
1	Jan. 11	1	Moose Mountain	Detonator
2	" 17	1	Colonial	Not known
3	" 20	1	Creighton	C. and H. Dynamite
4	" 22	1	Cobalt Lake	Cheddite
5	Feb. 8	1	No. 2 Mine	C. and H. Dynamite
6	" 20	3	Hudson Bay Gowganda	Cheddite
7	" 20	1	Garson	C. and H. Dynamite
8	Mar. 4	1	North Dome	Gelignite
9	" 7	1	Canada Iron Corporation	Dynamite
10	" 21	2	North Dome	Forcite
11	" 26	1	Cobalt Townsite	C.X.L. Dynamite
12	April 7	2	Intercities Quarry	Gelignite
13	May 20	2	Hudson Bay Cobalt	Forcite
14	" 20	2	Hollinger	C. and H. Dynamite
15	June 9	2	Miller Lake O'Brien	Forcite
16	July 1	1	Moose Mountain	Hamilton Dynamite
17	" 17	2	Perth Road Lead Mine	C.X.L. Dynamite
18	" 23	2	Dane Copper Co	C.X.L. Dynamite
19	Aug. 23	2	Coniagas	C.X.L. Dynamite
20	" 26	2	Hollinger Reserve	Forcite
21	Sept. 1	1	Magpie	C.X.L. Dynamite
22	" 6	1	Crean Hill	C. and H. Dynamite
23	" 8	3	North Star	Not known
24	" 17	2	Cobalt Lake	Dinitrolite
25	" 25	1	York Ontario	Forcite or Detonator
26	Oct. 14	2	Hollinger	C. and H. Dynamite
27	" 18	1	Creighton	C. and H. Dynamite
28	Nov. 17	1	Foley O'Brien	Forcite
29	" 29	2	Canada Cement Co	C.X.L Dynamite
30	Dec. 15	1	No. 3 Mine	Forcite
31	" 21	1	Crean Hill	Detonator
	TOTAL ..	47		

use of explosives during 1913.

Nature and cause of accident.
Held a lighted cigarette to detonator; 2 fingers and thumb blown off. Incapacitated for 48 days.
One report short, man returned as explosion occurred; eyes filled with dust. Incapacitated for 12 days.
Walked past sand blast as explosion occurred. Back and side cut and bruised. Incapacitated for 14 days.
Was starting a hole about 3 inches from old bottom. Spark probably ignited powder. Cheek bone fractured.
Explosion occurred while barring chute. Face and hand cut. Incapacitated for 11 days.
Miners using hand steel started drilling in an old bottom. Both were killed, and a trammer working nearby injured by shock.
Drilled into a missed or cutoff hole while blockholing. Incapacitated for 88 days.
While refiring round was overcome by gas and died five minutes after being brought to surface.
Walked into blast after ordinary warning had been given. Jaw fractured and ear blown off.
Started hole 2½ inches from collar of old hole and intersected old hole at 18 inches. Helper killed and runner totally blinded.
Hammer drill runner was killed while loading back holes. Flame from lamp probably ignited powder.
Powderman and helper killed while loading a 20-foot hole. Cause of explosion unknown.
Drilled into a cutoff hole. Helper killed and runner totally blinded.
Premature explosion caused by "quick" fuse, according to machine runner. Runner lived 8 days. The helper died from gas poisoning 3 hours after accident.
Shift boss had hand blown off, and helper slightly injured. Explosion occurred while removing powder from hole.
Plugger drill operator killed by drilling into powder in floor of open pit. Powder must have been there since 1910.
Drill runner and helper slightly injured. Fire from fuse ignited loose dynamite around collar of hole.
Drilled into cutoff hole. Drill runner and helper totally blinded.
Drill runner and helper killed while preparing to load holes. Cause of explosion unknown.
Drill runner and deckman killed. Probably removing tamping from hole with iron scraper.
Drill runner killed. Shooting in raise with battery, and had wires from charge wrapped around air-line. Lightning struck air-line on surface and exploded holes.
Did not seek shelter when blasters shouted warning. Shoulder bruised and arm cut. Incapacitated for 12 days.
Slight injuries. Premature explosion, due to holes not being properly tamped.
Removing shattered rock from collar of cutoff hole. Runner lost the sight of both eyes. Helper partially blinded.
Picked into explosive in broken ore. Injuries not serious.
Picking up bottom when explosion occurred. Injuries not serious.
Eye injured from premature explosion of sand blast. Powder not sufficiently covered.
Eyesight partially destroyed. Picking in broken ore when explosion occurred.
Tamping jammed cartridge when explosion occurred. Men received numerous cuts and bruises.
Head and eye injured. Drilled into explosive while blockholing.
Lighted a short piece of fuse with detonator attached and held same; 3 fingers blown off.

Miscellaneous Accidents

Eight men were killed underground during the year in miscellaneous accidents, an increase of 3 over the preceding year.

A trammer was killed at the Creighton mine, on January 15th, by being struck by falling ice.

At the same mine on May 26th, a chute blaster crawled part way into a chute to place powder. He was caught and killed by falling ore.

At the same mine on July 7th, a trammer was killed by being caught between a loaded and an empty car. This accident was due to powder smoke on the level from chute blasting, preventing the car crews from seeing one another in time to avoid a collision.

At the Garson mine on March 14th, a machine runner was killed by a rock rolling down the stope. Blasting to start a chute was the cause of the accident.

At the same mine, on October 9th, a shoveller, while starting the ore in the stope, was caught and carried down with the ore.

At the Victoria mine, on May 29th, a trammer was killed by falling in a stope from one level to another. This stope had been closed off, and the deceased crawled over the barricade.

At the Whistle mine, on July 4th, a miner, while helping to hoist powder in a raise was killed by a plank falling from the staging on which his partner was working.

At the Helen mine, on November 11th, a trammer was standing on arched ore over a chute. The chute was blasted, and the man killed by the run of ore.

Surface Accidents

Eight men were killed in surface accidents during 1913, an increase of two over the preceding year. Of these, three were killed in construction work, extremely cold weather being the cause of the accidents. Two men were electrocuted, in both cases while doing repair work.

At the Moose Mountain mill, on January 30th, an oiler was caught and killed in an unprotected gear while oiling a bearing.

At the Hollinger mill, on April 7th, a filter operator, while throwing on a belt, had his clothing caught on a shaft coupling and was killed.

One man was killed by a loaded tram-car falling on him while he was attempting to replace it on the rails.

Fuse Troubles

During the year many complaints have been received from the mining companies regarding the quality of the fuse on the market. The fuse trouble seemed to be more acute in the Cobalt camp than elsewhere.

On January 17th, at the Colonial mine, a miner was injured owing to the delayed or slow burning of a fuse. The brand of fuse used is not known.

On February 26th, the Trethewey Silver Cobalt mine reported that on two occasions their miners had narrow escapes from injury due to the quick action of the fuse. White Jacket fuse was the brand used.

On February 20th the Coniagas Mines wrote complaining about the quality of fuse supplied, but did not cite any special instance.

On May 20th at the Hollinger mine, two miners, while lighting a round of holes, noticed one fuse burning quickly and attempted to escape. The explosion occurred while they were crawling over the broken ore near the face. The miner succeeded in crawling out and getting help; he died eight days later in the hospital. His helper was not rescued for about half an hour owing to the gas at the face. He died three hours after being taken to the surface. The inspector who investigated this accident thought the holes might not have been properly tamped; but the miner, a man with several years' experience, swore positively that it was a "quick" fuse. The fuse was Crown brand.

On September 29th at the Crown Reserve mine, two men were leaving the face after lighting eleven holes, when about 100 feet distant, one of the holes exploded, but without injury to either of the men.

The fuse used was Clover brand, with a supposed burning speed of forty seconds to the foot. An investigation of the accident showed the fuse had a burning speed of thirty-two seconds to the foot.

Under date October 23rd, the McKinley-Darragh-Savage mines reported that they had two instances of "quick" fuse during the first week of October.

In the first case the man had lighted all his holes, and, as he was leaving, he noticed that the first hole held a "quick" fuse. He jumped down to the level and got under the timbers just as the hole exploded.

The second case occurred on the same or next day. After the man had lighted several holes he noticed one burning rapidly. He immediately cut this fuse but found that the fire had gone by. He ran out of the stope just as the hole exploded.

In each case "White Jacket" fuse was being used.

Under date October 21st, the Hollinger Gold Mines report as follows:—

On October 16th, two men were lighting holes in an underhand stope in the 100-foot level. The holes were tamped with water. Upon lighting one fuse the fuse flashed. The men were working three or four feet below the level, and when the fuse flashed they jumped on to the level and got about ten feet away before the hole exploded. Both men were knocked down, but aside from being shaken up a little and badly frightened they were not injured. Both men are positive that the fuse "ran." They are equally positive that the holes were tamped with water. Clover brand was the fuse used.

On November 8th at the Hollinger Gold Mines, two men were lighting 18 holes in a stope on the 100-ft. level. The eighteenth hole started to burn quickly. The men ran, and had time to get out of the stope and down to the level before the hole exploded. It took about one minute, as nearly as they could estimate, for the fuse to burn. The fuse was Crown brand.

The Canadian Copper Company, users of Beaver brand fuse, report trouble with this fuse, in that the outer covering seems to be inflammable.

This fuse is manufactured by Noebels Limited, Glasgow, Canadian Explosives Limited being the agents.

The Crown brand fuse is manufactured by William Bennett, Sons & Company Cambourne, Cornwall, England. Leckie & Collis, Limited, Napanee, Ont., are agents

The Clover brand fuse is manufactured by the Ensign-Bickford Manufacturing Company, of Simsbury, Conn. Grodwards Company, Cobalt, are the agents.

White Jacket fuse is manufactured by Bickford, Smith and Company, Tuckingmill Cornwall, England. Mussens, Limited, Montreal, are agents.

Prosecutions

Before Magistrate Brodie at Sudbury, an employee of the Creighton mine was fined $25 and costs for a violation of Rule 31 of the Mining Act. His companion, Louis Pero, left the camp and could not be located. These men were riding on the skip.

Before Magistrate Brodie at Copper Cliff, on November, 22nd, three men were each fined $20 and costs for being under the influence of liquor at the Creighton mine.

Before Magistrate Atkinson, at Cobalt, on February 7th, the Cobalt Lake Mining Company were fined $100 and costs for violation of Rule 36, Sec. 164 of the Mining Act of Ontario, in that a closed hook was not used for hoisting, on January 13th.

Before Magistrate Atkinson, at Cobalt, on February 7th, the Right of Way Mining Company were fined $250 and costs for a violation of Rule 33, Sec. 164 of the Mining Act, the cross-head not being equipped with a proper safety appliance.

Before Magistrate Atkinson, at Cobalt, on February 14th, Emil Niemi, an employee of the Nipissing Mining Company, was fined $10 and costs for a violation of Rule 46, Sec. 164 of the Mining Act, in ringing the signal bell, he not being the cage tender, and in giving the signal to move the cage when the same was not at the level at which the signal was given.

Before Magistrate Brodie, at Sudbury, on February 20th, The Moose Mountain, Limited, was fined $100 and costs for a violation of Rule 47, Sec. 164 of the Mining Act of Ontario, in not having geared wheels properly enclosed by a casing on January 30th.

Before Magistrate Hunter, at Kingston, on August 25th, the North American Smelting Company were fined $100 and costs for an infringement of Rule 5, Sec. 164 of the Mining Act. This company owns the Perth Road Lead mine, and blasting at an air shaft at No. 3 mine was not done by means of an electric current.

Before Magistrate Brodie at Sudbury, on September 29th, the shift boss at the Murray mine was fined $15 and costs, and the hoistman at the same mine $20 and costs. These men were guilty of an infringement of Rule 97, Sec. 164 of the Mining Act in that they were intoxicated while on shift.

Before County Magistrate R. R. Casement, at Madoc on October 3rd, the Canadian Sulphur Ore Company were fined $100 and costs for an infringement of Rule 23, Sec. 164 of the Mining Act. At the pyrite mine of this company, near Queensboro, the main shaft was being continued below the first or 118-foot level. Hoisting from the first level was carried on without making provision for the safety of the men engaged in sinking operations.

Before Justice of the Peace Weston, at Timmins, on May 23rd, a machine runner at the Hollinger gold mine was fined $10 and costs for drilling into a hole which had previously been blasted.

Health of Miners

The general health of workmen in the different camps has continued good during the past year. There were very few cases of typhoid in Northern Ontario mining camps.

With regard to miners' phthisis there does not seem to be any change from a year ago. A few cases are known among the older miners. The absence of many known cases among the miners of Ontario does not prove that conditions underground are satisfactory as regards gas and dust, since the accident reports show that seventy per cent. of the men injured in the mining industry of Ontario were under thirty-one years of age. Attempts were made during the past year to lessen the dust from drilling operations by having hammer drills equipped with a water spray. This was not a success, due partly to mechanical defects in the spray itself, and partly to the opposition of the hammer-drill operators. The spray choked up easily, and required considerable care to keep in good working order. The men objected to this trouble; also to carrying water up raises, stopes, etc., and many complained that the spray wet the operator. As the use of the spray undoubtedly decreases the footage drilled, the foremen and managers probably gave more serious consideration to these objections than they otherwise would have done.

The opinion of those making a study of this subject in South Africa is that the gas and dust from blasting operations is the main cause of phthisis. In this connection the Rand Daily Mail published the following in its editorial columns of August 13th, 1913:—

> In the recently published interim report of the Miners' Phthisis Prevention Committee, special emphasis was laid upon the dangerous nature of the dust caused by blasting operations underground. In the first place it was shown that after general blasting an unusually large amount of dust was present in the air. In the second place it was "provisionally stated" that the dust originated by blasting "most closely resembles the dust incarcerated in the silicotic lung." It is obvious, therfore, that any system which can keep men out of the mines during, and after, blasting, must be of value in helping to safeguard them against the scourge of the Reef. Some time ago we strongly urged the introduction of the plan of blasting by electricity from the surface. Evidence was given of the success of this method in the Witbank collieries, and Mr. E. J. Moynihan, who is an authority on mining matters, supported the suggestion in several practical letters. To-day we are able to announce that an important experiment has been planned by the management of the Albu group. The heads of the group have all along taken a keen personal interest in the question, and it has been decided to equip the Meyer and Charlton mine with the fittings necessary for using the general blast by electricity.
>
> The report of the Phthisis Committee disclosed the small amount of success achieved by many of the expedients now in force for reducing the amount of dust in the atmosphere underground. It was made plain that drastic action is essential for the protection of the workers. The elimination of present-day blasting methods seems to be an important factor in the obtaining of better conditions, and the general blast by electricity controlled from the surface offers one solution of a difficult problem.

Under the date of September 4th, 1913, Mr. Moynihan states that the experiments at the Meyer and Charlton mine were so satisfactory that it was the intention of the management to adopt this system throughout the whole mine.

The following quotations from the Report of the Mining Regulation Commission of the Transvaal show the prevalence of miner's phthisis and the means recommended to mitigate the evil:—

> It is well known that persons such as cutlers, potters, quarrymen, filemakers, felt hat finishers, lead and tin miners, who are more or less continuously inhaling hard, sharp, irritating dust, show an undue mortality from respiratory disease after the age of about 35. Naturally this is less marked in the case of open-air workers such as quarrymen than in men who work underground or in cover. On the other hand, in the case of rock-drillers, this mortality begins much earlier and is much heavier. From the reports of the Transvaal Government Mining Engineer for 1901 and 1902 (quoted by Dr. Haldane) it appears that between October, 1899, and January, 1902, the war being in progress and mining operations practically suspended, the annual death rate among the men who had been employed in the Transvaal as rock-drillers before the war was no less than 73 per 1,000, and this during a period when the great majority were not actually engaged in rock-drill work. The corresponding figure for Cornish rock-drillers is estimated by Dr. Haldane at about 60 per 1,000; while the Victorian statistics, published by Dr. Summons, indicate that in the Bendigo mines the mortality is higher even than in the Transvaal. The disease has consequently been the subject of careful official inquiry in all these localities, viz., in the Transvaal by the Miners' Commission of 1902-03; in Cornwall by Dr. Haldane, with Messrs. Martin and Thomas, who reported in 1905 "On the Health of Cornish Miners"; in Australia by the Commission of 1905 "On the Ventilation and Sanitation of Mines in Western Australia," as well as by Dr. Walter Summons who in 1907 published an excellent and illuminating report on miner's phthisis at Bendigo, Victoria. In each of these localities miner's phthisis has very greatly increased since the general introduction of rock-drills into practice, and those who have investigated the matter are generally agreed as to the nature of the disease, which is thus summarized by Drs. Irvine and Macaulay:—

"It is primarily a chronic disease of the lungs, characterized by slow but progressive fibroid changes in the lung tissue and the pleuræ, accompanied by chronic catarrhal processes in the air-cells and respiratory passages. All are agreed that immensely the most important factor in producing this condition is the more or less continuous inhalation over long periods of fine rock-dust. All true cases of miner's phthisis are thus primarily cases of silicosis; silicosis is the feature common to them all. Finally, it is agreed that, in the later stages, tuberculous infection commonly, or invariably, becomes super-imposed upon this condition, and the symptoms and course of the disease alter accordingly."

Duration of the Disease.—From the evidence before us it appears that, in the past, the average age at death of rock-drillers dying from silicosis in the Transvaal was thirty-five years, and the average period of rock-drill employment was seven to nine years. Dr. Haldane gives the following figures for rock-drillers dying in Cornwall:—

Where work has been done	Average Age at Death in 142 cases	Average Period of Rock-drill Employment when ascertainable
Cornwall only	37.5	8.4
Cornwall and Transvaal	36.4	4.7
Transvaal only	36.3	11.6

During 1905-7 the average age of mine employees dying of phthisis on the Rand was 39 years. At Bendigo, the incidence of the disease is, as already pointed out, considerably heavier than on the Rand, but the average age at death is much higher than here, viz., year by year just under or above fifty years, the presumption being that the development of silicosis is much more gradual and the Bendigo miner's term of active usefulness correspondingly longer.

Preventive Measures.—From the foregoing considerations it is clear that our efforts must be directed to

1. The prevention of dust inhalation;
2. The prevention or removal of noxious fumes resulting from explosives;
3. The prevention of tuberculosis.

(1) The Prevention of Dust Inhalation.—The rock-driller is far more exposed to dust than any other miner. This dust is produced (*a*) by drilling dry holes and (*b*) by blasting. In dry working places it is raised again after its subsidence (*a*) by the air escaping from the rock-drills and (*b*) by the lashing or shovelling of broken rock which is not wet. Holes drilled from above downwards are usually kept filled with water, and, as work progresses, exude only mud; "backholes," or holes drilled from below upwards, will obviously not retain water, and unless a jet or spray be played upon them, give off a continuous stream of fine dust. The chief occasions of dust inhalation are therefore (*a*) when the escaping air from the rock-drills raises the dust from the floor and sides of dry working places; (*b*) in drilling backholes; (*c*) on returning to the working face after blasting before the dust has had time to subside; and (*d*) in lashing without keeping the rock thoroughly wet.

Ventilation of Mines

During the year only two deaths resulted from gas poisoning; in both cases the fatality would not have occurred could rescuers have reached the men sooner. Pulmotors are now installed at the following places: Hollinger mine, 1; Dome Hospital, 1; Cobalt Mines Hospital, 1; Canadian Copper Company, Copper Cliff, 5; The Steel Company of Canada, Hamilton, 1; Algoma Steel Corporation, Sault Ste. Marie, 2.

Assistant Inspector of Mines Collins writes as follows regarding the use of the pulmotor at the plant of The Steel Company of Canada:

I wish to bring to your attention the following cases of resuscitation by the use of the pulmotor reported by Sergeant Matthews, in charge of the first aid dispensary, The Steel Company of Canada's plant, Hamilton, Ont.:—

A. Walker was overcome by gas at the blast furnace on March 3rd last and carried into the dispensary unconscious. His pulse was very weak, and it was apparent that he had inhaled a large volume of gas and could not throw it off. Mr. Matthews used the pulmotor continuously for fifteen minutes and natural breathing was restored. In a short time he was able to resume work.

Filis Bausch was overcome by gas at the open-hearth plant on April 17th. When brought to the dispensary he was bleeding at nose and mouth and no pulse could be detected. Mr. Matthews was able to start natural breathing by fifteen minutes' treatment with pulmotor, and at the end of one hour and a quarter Bausch was able to walk home, being afterwards treated at the hospital.

Mr. Matthews is an expert first aid man, and informed the writer that both cases were extremely bad, and would undoubtedly have ended fatally had it not been for the pulmotor treatment.

The necessity of a pulmotor in cases of electric shock is shown in the following letter from the city of Port Arthur, dated November 12th, 1913:—

We have just had an opportunity this morning of demonstrating the pulmotor to be installed in the Hydro-Electric Power Commission's sub-station, this city. One of the linemen came in contact with a high-tension wire, one side of a 23,000 volt line, and was completely knocked out when the pulmotor was applied, and we had him breathing normally when the doctor arrived. We think that this was the means of saving this man's life. The man is now in the hospital and apparently doing all right.

Treatment of Gassing

1. Every case of gassing should be at once reported to the shift boss and by him to the mine manager either directly or through the mine captain.

2. All cases of gassing should be brought to the fresh air as quickly as practicable, and kept warm by the application of warm clothing and other external means. The common practice of sousing such cases externally with cold water and of administering whiskey or brandy internally should on no account be employed, because of the physiological shock produced.

3. If the sufferer can swallow, an emetic (one ounce of sulphate of zinc solution, strength 30 grains to ounce) should be at once given, and repeated every ten minutes till vomiting results.

4. When vomiting has occurred, a dose of two teaspoonfuls in water of aromatic spirits of ammonia (sal volatile) should be administered.

5. Artificial respiration should be started and continued as long as there is any indication of life, the patient thereby being made to inhale oxygen through a mask. Oxygen in such cases is invaluable; carbon monoxide is eliminated five times as rapidly in an atmosphere of oxygen as in air, and in nitrous fumes poisoning the beneficial effect of oxygen on the terrible distress of pulmonary œdema is most marked.

In the latter treatment of nitrous fumes gassing, the medical attendant may have to resort to saline transfusion and liberal blood-letting.

6. All cases of gassing, however slight, should be kept under medical observation for at least twelve hours.

We therefore submit the following recommendations:—

(*a*) That the legal maximum for noxious CO_2 permissible in mines in the Transvaal be fixed at 8 parts by volume in 10,000 of air.

(*b*) That an amount of 4 parts of CO_2 by volume in 10,000 of air shall be allowed in addition to the aforesaid maximum as representing innocuous CO_2 normally present in the atmosphere.

(*c*) That where candles or similar illuminants are in use, a further addition of 3 parts of CO_2 by volume in 10,000 of air shall be allowed as representing innocuous CO_2 resulting from the combustion of such illuminants.

(*d*) That in order to meet, from the point of view of practical administration, difficulties in regard to possible innocuous CO_2 from country rock and other uncertain sources in the mines of the Rand, a further allowance of 5 parts per 10,000 be made, making a total limit of 20 parts per 10,000 of air. That in view of the extremely poisonous effects of carbon monoxide and nitrous fumes on the human system, and the frequency of gassing fatalities on the Rand, we also recommend that the maximum permissible amount of carbon monoxide in any part of a mine shall not exceed .01 per cent., and no practically determinable amount of nitrous fumes shall be permitted in any part of a mine.

Mine Hospitals

The last annual report of the Hospital Board of the Cobalt Mines Hospital for the year ending February 28, 1913, notes that additional surgical and X-ray appliances were added to the surgical department; that sun parlors and verandahs were added to the building; and that over $2,000 were spent in beautifying the grounds.

Patients in Hospital March 1st, 1912	9	
Patients admitted during year	447	
		456
Patients discharged during year:—		
Deaths	11	
Recovered	422	
		433
Patients in Hospital March 1st, 1913		23
Average patients per day in Hospital		18.4
Average days per patient in Hospital		14.7

——	Deaths	Per cent. Deaths	Per cent. Recovery
Pneumonia	2	15	85
Cancer	1	....	....
Convulsions	1	....	....
Spinal Meningitis	1	....	....
Typhoid	1	14.3	85.7
Accidents	5	3.2	96.8
Medical cases	6	3.3	96.7
Surgical cases	5	1.85	98.15
Total cases	11	2.46	97.54

The new hospital at Copper Cliff being built by the Canadian Copper Company at a cost, when equipped, of $250,000, is expected to be ready for occupancy by February 15th, 1914.

The building is two storeys, with basement and sub-basement, and is fireproof throughout, being constructed of reinforced concrete and tile, with tile floors and slate shingles.

The main building is 191 feet by 36 feet, with a 73-foot by 55-foot wing.

On the ground floor are the doctors' and head nurse's offices, surgical ward, two typhoid wards, four private wards, bathrooms, closets, medicine room, dispensary and drug room, X-ray room, dark room and operating room; also kitchen, dining room, etc. There are two sun parlors, 34 feet by 13 feet, one on each end of the main building.

On the second floor there are five private wards, one semi-private ward, electrical kitchen, bathrooms, doctors' bedrooms and sitting-rooms, linen and sewing rooms, and balcony.

The basement has ten rooms fitted up for the help, bathrooms, laundry and dry room; also a morgue and post-mortem room.

The sub-basement contains the heating plant and an ice-making plant.

There are two well-equipped hospitals in Porcupine, one at the Dome in charge of Dr. McNeil and the other at Timmins in charge of Dr. Moore.

Labor

During the first part of the year there was a scarcity of labour in the mining camps. In the latter part of the year there was an excess of unskilled labour. Good miners can always obtain employment in any of the Northern Ontario mining camps. The Porcupine strike was allowed to lapse in the early part of the summer; there has been no other labour disturbance during the past year.

On January 1st, 1914, the Eight-hour Act came in force in the majority of the mines of Ontario. This Act calls for eight hours from face to face. In Cobalt and Porcupine the majority of the mines are working two eight-hour shifts. In Sudbury the general practice is to employ three shifts of eight hours each. The mines of Eastern Ontario and the iron mines in operation last year are exempted, although the Moose Mountain iron mines are employing two shifts of nine hours from change room to change room.

Table of Fatal Accidents in

No.	Date 1913	Name of Mine.	Name of Owner.	Name of Deceased.	Occupation of Deceased.
1	Sept. 1	Magpie	Algoma Steel Corporn.	Luigi Del Favero.	Drill runner
2	Nov. 11	Helen	do do	L. Pecile	Trammer
3	Jan. 5	Creighton	Canadian Copper Co.	L. Dishno	Powderman
4	" 15	Creighton	do do	M. Wazniz	Trammer
5	Feb. 15	No. 3	do do	C. Wadsworth	Laborer
6	May 26	Creighton	do do	J. Maki	Chute tender
7	June 3	Crean Hill	do do	A. Johnson	Pipe fitter
8	July 7	Creighton	do do	T. Serefini	Trammer
9	Oct. 28	do	do do	E. Vinzelli	Lamp tender
10	Dec. 9	do	do do	A. Dylej	Chute tender
11	July 14	Long Lake	Canadian Exploration Co., Ltd.	P. Grabowski	Skip tender
12	Feb. 22	Alexandra	Canadian Gold and Silver Mining Co.	Thos. McAndrews	Trammer
13	" 18	Cobalt Lake	Cobalt Lake Mining Co.	Nikola Gaiena	Trammer
14	Mar. 26	Cobalt Townsite	Cobalt Townsite Mining Co.	P. Sjokvist	Drill runner
15	Aug. 23	Coniagas	Coniagas Mines, Ltd.	S. Brigden	Drill runner
	" 23	Coniagas	Coniagas Mines, Ltd.	V. Laiho	Drill helper
16	Mar. 17	Henderson	Cross and Wellington	Fred Rogers	Trammer
	" 17	Henderson	Cross and Wellington	Stephen Milan	Trammer
17	July 4	Whistle	Dominion Nickel Copper Co.	P. Lichvazuk	Drill runner
18	Ap'l 17	Hollinger	Hollinger Gold Mines, Ltd.	E. Eudier	Millman
19	May 20	do	do do	A. Gino	Drill helper
	" 20	do	do do	M. Gabbro	Drill runner
20	Aug. 26	Hollinger Reserve	Hollinger Reserve Mining Co.	J. Nolan	Drill runner
	" 26	do	do do	M. Tereske	Deckhand
21	Jan. 8	McIntyre	McIntyre Porcupine Mines, Ltd.	R. E. Dube	Carpenter
	" 8	McIntyre	do do	O. Charon	Carpenter
22	" 14	Garson	Mond Nickel Co.	O. Malynk	Trammer
23	" 20	Frood Extension.	do	W. Norme	Drill runner
24	Mar. 14	Garson	do	Biglig Urin	Drill runner
25	May 29	Victoria	do	G. Pednud	Trammer
26	Aug. 29	Frood Extension.	do	J. Knaapi	Drill runner
27	Oct. 9	Garson	do	W. Lazovowitz	Trammer
28	Jan. 30	Moose Mountain	Moose Mountain, Ltd.	J. McGregor	Oiler
29	July 1	Moose Mountain.	Moose Mountain, Ltd.	E. Yarvii	Drill runner
30	Jan. 15	Nipissing	Nipissing Mining Co.	A. Lefebre	Cage tender
31	Feb. 16	do	do do	J. McGoff	Drill runner
32	Aug. 22	do	do do	F. Guiseppi	Trammer
33	Mar. 4	North Dome	North Dome Mining Co.	N. Carlos	Drill runner
34	" 20	North Dome	do do	S. Musmici	Drill helper
35	Jan. 8	Right of Way	Right of Way Mining Co.	J. Colterman	Drill runner
36	Mar. 25	Temiskaming	Temiskaming Min'g Co.	J. Koniadina	Trammer
37	July 22	Temiskaming	Temiskaming Min'g Co.	G. Montgomery	Electrician
38	Feb. 20	Hudson Bay	Temiskaming & Hudson Bay Mining Co.	W. McGuiness	Drill runner
	" 20	do	do do	D. McNair	Drill helper
39	May 20	do	do do	E. Poisson	Drill helper

or about the Mines, 1913.

Nationality of Deceased.	Age	Married or single	Above ground	Below ground	Cause of Accident.
Italian	27	S	.....	1	Premature explosion in raise.
Italian	26	S	.....	1	Standing on arched ore in raise. Ore settled, smothering him.
English-speaking	25	S	.....	1	Fell off skip and fractured skull.
Pole	35	M	.....	1	Skull fractured by piece of falling ice.
English-speaking	26	S	1	......	Fell fifteen feet from platform and broke neck.
Finn	26	M	.....	1	Crawled into chute, caught by fall of ore.
Finn	26	M	1	......	Electrocuted in pumphouse.
Pole	25	M	.....	1	Crushed between two cars on fifth level.
Italian	21	S	.....	1	Jumped from moving skip at fourth level.
Pole	37	M	.....	1	Crushed on fifth level when pillars caved.
Pole	30	S	.....	1	Killed while attempting to ride skip.
English-speaking	30	S	.....	1	Struck by falling crosshead.
Pole	28	M	.....	1	Attempted to board moving cage.
Swede	35	M	.....	1	Premature explosion, while lighting holes.
English-speaking	30	M	.....	1	Explosion of dynamite in stope, cause unknown.
Finn	24	S	.....	1	
English-speaking	35	M	.....	1	Crushed by falling ground.
English-speaking	26	S	.....	1	
Pole	37	M	.....	1	Killed in raise by falling plank.
French	20	S	1	......	Clothing caught in shafting.
Austrian	32	M	.....	1	Premature explosion while lighting holes. Died May 28th.
Austrian	29	M	.....	1	
English-speaking	22	S	.....	1	Premature explosion while removing tamping from missed holes with iron scraper.
Pole	25	S	.....	1	
English-speaking	22	M	1	....	Chord of roof truss of new mill broke. Fell fifty feet. Died January 24th.
English-speaking	20	S	1	....	
Pole	28	S	.....	1	Struck by falling ground while scaling.
Finn	23	S	.....	1	Struck by piece of falling plank.
Austrian	26	M	.....	1	Crushed by rock rolling down stope.
Austrian	32	M	.....	1	Fell in stope from ninth to tenth level.
Finn	24	S	.....	1	Cable broke, struck by falling bucket.
Austrian	35	M	.....	1	Starting mill hole, was carried down with ore.
English-speaking	40	M	1	......	Clothing caught in revolving gear.
Finn	35	M	.....	1	Drilled into explosive.
English-speaking	28	M	.....	1	Fell in shaft from cage while unloading steel.
English-speaking	34	S	.....	1	Staging gave way while timbering in winze.
Italian	37	M	1	......	Crushed by loaded car while trying to replace car on track.
Italian	35	M	.....	1	Asphyxiated while relighting holes.
Italian	35	M	.....	1	Drilled into missed hole.
English-speaking	25	S	.....	1	Struck by falling crosshead.
Austrian	32	M	.....	1	Crushed by fall of ground.
English-speaking	19	S	1	......	Electrocuted while replacing telephone line on high tension line.
English-speaking	61	M	.....	1	Started drilling into old bottom.
English-speaking	30	S	....	1	
English-speaking	22	S	....	1	Drilled into cut-off hole.
	Totals ..		8	37	

Table of Non-Fatal Accidents

No.	Date of Accident.	Date of Recovery.	Name of Mine.	Name of Owner.	Name of Injured.	Occupation of Injured.
1	Sept. 17	Dec. 29	The Alabastine Co.,	The Alabastine Co., Ltd.	Jas. Perkins	Drill helper
2	Nov. 17	" 15	do	do do	E. Aaron	Laborer
3	" 29	Jan. 5	do	do do	G. Carpenter	Teamster
4	Jan. 25	Feb. 8	Magpie	Algoma Steel Corporn.	P. Conigle	Trammer
5	May 19	June 2	do	do do	O. Hulkanen	Drill runner
6	" 24	May 31	do	do do	B. Vincenzo	Trammer
7	" 18	June 2	do	do do	A. Garrepy	Painter
8	July 4	July 20	Helen	do do	W. Matheson	Blacksmith
9	Aug. 1	Aug. 11	do	do do	J. Berich	Trammer
10	" 13	" 22	Magpie	do do	S. Chowanski	Crusherman
11	Sept. 15	Oct. 9	Helen	do do	Guiseppe de Meio	Blacksmith's helper
12	Oct. 6	" 20	do	do do	J. Borich	do
13	" 14	Nov. 3	do	do do	J. Trtanz	Drill runner
14	Nov. 19	" 27	do	do do	A. De Zordo	Drill runner
15	Dec. 7	Dec. 15	Magpie	do do	R. Muscatello	Laborer
16	Sept. 17	Nov. 14	Bailey	Bailey Cobalt Mines, Ltd.	A. Moitemise	Trammer
17	Nov. 10	" 22	Beaver	Beaver Con. Mines, Ltd.	J. Swajozike	Deckman
18	Feb. 21	Mar. 25	Buffalo	Buffalo Mines, Ltd.	P. Troutman	Trammer
19	Ap'l 21		do	do do	J. R. Hawley	Carpenter
20	Sept. 19	Nov. 15	do	do do	H. Nichol	Carpenter
21	Dec. 4	Dec. 17	do	do do	P. B. Johnson	Millman
22	" 22		do	do do	J. Kasparak	Trammer
23	July 2		Bessemer	Canada Iron Mines, Ltd.	R. Haggarty	Drill runner
24	Jan. 4	Feb. 5	No. 2	Canadian Copper Co.	Victor Jairainen	Chute blaster
25	" 4	Jan. 20	Creighton	do do	Otto Malinere	Drill runner
26	" 5	Mar. 5	do	do do	J. W. Brown	Level boss
27	" 5	Feb. 17	do	do do	Waino Wista	Drill helper
28	" 9	Jan. 18	do	do do	Robt. Saari	Drill helper
29	" 10	Feb. 24	do	do do	Mytro Stalmuk	Trammer
30	" 15	" 7	No. 3	do do	C. D. Crawford	Trammer boss
31	" 16	" 3	Creighton	do do	C. Nachoff	Trammer
32	" 19	Jan. 29	do	do do	W. Turnbull	Timberman
33	" 20	Feb. 3	do	do do	J. Maampaa	Drill runner
34	" 20	Jan. 28	do	do do	O. Obumsaioin	Drill runner
35	" 21	Feb. 6	No. 2	do do	Frank Stone	Trammer
36	" 24	" 10	Creighton	do do	Geo. Mattson	Drill runner
37	" 24	Mar. 3	do	do do	G. Spranka	Drill runner
38	" 26	Feb. 25	do	do do	J. Maki	Drill runner
39	" 27	" 17	do	do do	Ivan Station	Trammer
40	" 30	" 26	do	do do	Jas. Cmejnteniz	Trammer
41	Feb. 1	" 25	Crean Hill	do do	Donald McDonald	Shift boss
42	" 1	Mar. 11	Creighton	do do	Jas. Hughes	Timberman
43	" 2	Feb. 25	do	do do	Geo. Waloshuk	Drill helper
44	" 4	" 14	do	do do	C. Virginio	Laborer
45	" 7	" 15	Crean Hill	do do	F. J. Baker	Mechanic
46	" 8	Apl. 8	Creighton	do do	C. Blanchard	Drill runner
47	" 8	Feb. 19	do	do do	Peter Smith	Trammer

in or about Mines, 1913.

Nationality of Injured.	Age.	Married or single.	Below ground.	Above ground.	Nature and Cause of Accident.
English-speaking....	42	M	1	......	Injured leg while barring rock from face.
English-speaking....	35	M	.....	1	Knocked off top of car in yard and injured hip.
English-speaking....	23	S	1	......	While riding on loaded car had leg caught between loaded car and empty at switch.
Italian............	19	S	1	......	Pulling tramcar and foot caught by flange of wheel.
Swede.............	26	......	1	......	While tightening nut on machine, slipped and fell into stope.
Italian..............	24	......	1	......	Foot bruised by rock falling out of chute.
Italian..............	24	......	.....	1	Hand crushed against iron girder.
English-speaking....	23	......	.....	1	Fell while carrying drill machine and broke ankle.
Pole................	24	......	1	......	Car ran over finger.
Russian............	21	S	.....	1	Clothing caught in flywheel of sample crusher and three ribs broken.
Italian............	31	......	.....	1	Dropped piece of iron on foot.
Pole................	25	......	.....	1	Struck thumb with hammer.
Finn...............	30	......	1	......	Large piece of clay rolled against ankle.
Italian..............	26	......	1	......	Piece of rock fell on head.
Italian.............	20	......	.....	1	Slipped off plank and sprained ankle.
Italian..............	....	......	1	......	Hand injured at chute.
Russian............	....	......	.....	1	Went over end of dump with car.
Pole................	45	M	1	......	Struck on head by steel falling down unused shaft.
English-speaking....	30	M	.....	1	Fingers caught in planer.
English-speaking....	30	M	.....	1	Ankle sprained and right arm broken when jumped from staging.
English-speaking....	45	M	.....	1	Wrench slipped and hit him over eye.
Pole................	35	M	1	......	Thumb broken while loading car at chute.
English-speaking....	24	S	1	......	Rock fell on foot.
Finn................	30	S	1	......	Rock fell down chute, injuring hand.
Finn................	29	M	1	......	Drill fell on him as he was pulling it down.
English-speaking....	29	M	1	......	Hand amputated, fell from skip while riding.
Finn................	23	S	1	......	Scalp cut by piece of falling ice.
Finn................	39	M	1	......	Arm bruised by drill falling on it.
Pole................	33	S	1	......	Wrist bruised, caught between car and door.
English-speaking....	23	S	1	......	Fell into sump and injured knee.
Bulgarian...........	27	S	1	......	Finger jammed while dumping car in skip.
English-speaking....	37	S	1	......	Head cut, struck by chute gate.
Finn...............	23	S	1	......	Back cut, struck with rock from blast.
English-speaking....	22	S	1	......	Drill fell on foot, injuring same.
Finn...............	25	S	.....	1	Struck on foot by hammer.
Finn...............	32	S	1	......	Fell over end of dry wall and injured his side.
Pole................	32	S	1	......	Finger jammed between tripod and rock.
Finn................	23	S	1	......	Drill fell on hand, crushing second finger.
Pole................	28	S	1	......	Thumb crushed between car and chute gate.
Pole................	30	M	1	......	Rock rolled down pile and bruised ankle.
English-speaking....	39	M	1	......	Slipped on ladder and bruised knee.
English-speaking....	28	S	1	......	Finger crushed under piece of timber.
Pole................	23	S	1	......	Face cut by piece of falling rock.
Italian..............	25	S	1	......	Head cut by small piece of rock falling from chute.
English-speaking....	35	M	1	......	Oiling valve with coal oil, which ignited, and burned face.
English-speaking....	24	S	1	......	Ankle cut by piece of rock sliding off bench.
Pole................	23	S	1	......	Bolt of car struck him on knee.

Table of Non-Fatal Accidents

No.	Date of Accident.	Date of Recovery.	Name of Mine.	Name of Owner.	Name of Injured.	Occupation of Injured.
48	Feb. 8	Feb. 19	No. 2	Canadian Copper Co.	T. Eralla	Trammer
49	“ 9	“ 21	Creighton	do do	Victor Piri	Drill runner
50	“ 9	Mar. 13	do	do do	J. Modiste	Trammer
51	“ 10	Feb. 25	No. 2	do do	Ed. MacKinnon	Chute blaster
52	“ 11	May 12	Creighton	do do	S. Pesqual	Skip tender
53	“ 11	Mar. 17	do	do do	F. Karpinski	Trammer
54	“ 16	“ 2	No. 3	do do	A. Avicksonin	Drill runner
55	“ 18	Feb. 28	Creighton	do do	K. Hanitenan	Drill helper
56	“ 19	Mar. 4	Crean Hill	do do	M. Dolvowolski	Crusherman
57	Mar. 1	Apl. 15	Crean Hill	do do	Jas. Lindella	Drill helper
58	“ 1	Mar. 10	Creighton	do do	S. Aatanasoff	Trammer
59	“ 5	“ 13	No. 3	do do	S. Guiseppi	Laborer
60	“ 5	“ 26	Crean Hill	do do	Geo. Seymour	Drill runner
61	“ 5	“ 19	No. 3	do do	L. Dececkio	Drill helper
62	“ 6	“ 20	Crean Hill	do do	M. Mazowick	Trammer
63	“ 9	“ 24	Creighton	do do	G. Calendoni	Straw boss
64	“ 10	“ 24	No. 2	do do	L. Holamas	Trammer
65	“ 12	“ 20	No. 2	do do	Elmer Johnson	Drill runner
66	“ 14	June 26	Creighton	do do	Karl Bossell	Drill runner
67	“ 14	Ap'l 8	No. 2	do do	Emil Kantamaki	Drill runner
68	“ 17	Mar. 27	No. 2	do do	Sam Wuori	Drill helper
69	“ 18	Ap'l 2	No. 3	do do	F. Ranislo	Laborer
70	“ 20	May 21	Creighton	do do	W. Rahkala	Drill helper
71	“ 20	Ap'l 1	No. 2	do do	Alex. Rantenan	Trammer
72	“ 24	“ 3	No. 2	do do	John Smith	Drill helper
73	“ 26	“ 4	Creighton	do do	W. G. Shute	Fitter
74	“ 31	June 10	do	do do	F. Bosmavinuk	Trammer
75	Ap'l 1	Ap'l 22	Crean Hill	do do	Mike Krazy	Trammer
76	“ 1	“ 10	No. 3	do do	W. Maki	Drill runner
77	“ 4	“ 12	Creighton	do do	Wryc Monyez	Ore sorter
78	“ 7	“ 22	do	do do	E. Saari	Drill helper
79	“ 8	“ 17	No. 2	do do	J. Westerpakka	Trammer
80	“ 9	June 26	Creighton	do do	N. Korpi	Drill runner
81	“ 13	Aug. 4	do	do do	E. Creitzman	Machinist
82	“ 14	May 14	do	do do	L. Dunkovictaki	Trammer
83	“ 14	“ 1	No. 2	do do	A. Bulki	Drill helper
84	“ 15	Ap'l 23	Creighton	do do	B. Toderico	Trammer
85	“ 17	May 5	Crean Hill	do do	W. Linn	Drill helper
86	“ 18	Ap'l 30	No. 2	do do	J. Lormy	Skip tender
87	“ 21	May 6	Creighton	do do	O. Szeczuck	Trammer
88	“ 22	“ 5	No. 2	do do	A. Bartollotti	Trammer boss
89	“ 30	“ 20	Creighton	do do	M. Soczuk	Drill helper
90	May 1	“ 12	Creighton	do do	J. Servioni	Trammer
91	“ 2	July 25	do	do do	D. Coaston	Trammer
92	“ 2	May 13	No. 3	do do	C. Giovanni	Carpenter
93	“ 3	“ 14	Crean Hill	do do	G. Hill	Drill runner
94	“ 3	“ 17	do	do do	M. Paanamen	Drill helper
95	“ 3	“ 28	do	do do	P. Bardyk	Drill helper
96	“ 5	“ 13	No. 2	do do	P. Masalin	Trammer

in or about Mines, 1913—Continued

Nationality of Injured.	Age.	Married or single	Below ground.	Above ground.	Nature and cause of accident.
Italian	37	S	.....	1	Fell down steps and broke arm.
Italian	27	S	1	......	Stoping drill fell and struck him on head.
Italian	37	S	.....	1	Fell down steps and broke arm.
Finn	23	M	1	......	Piece of ore fell from car, crushing foot.
Italian	47	M	1	......	Hand caught between car and skip.
Pole	25	S	1	......	Finger cut off in chute air lift.
Finn	23	S	1	......	Timber fell on finger while timbering shaft.
Finn	20	S	1	......	Finger pinched between drill and rock.
Pole	28	M	.....	1	Finger crushed under rock while feeding crusher.
Finn	22	S	1	......	Fell off bench in stope and fractured skull.
Bulgarian	21	S	1	......	Leg cut by piece of ore rolling down stope.
Italian	22	S	.....	1	Fingers pinched while helping to move hoist.
English-speaking	26	S	1	......	Fell off bench in stope and sprained ankle.
Italian	29	S	1	......	Finger cut by piece of steel falling against him.
Pole	24	S	1	......	Finger cut between rock and side of car.
Italian	28	M	.....	1	Toggle plate of crusher fell on his foot.
Finn	21	S	1	......	Fell about twelve feet in ladderway and injured hip.
Finn	22	S	1	......	Head cut by small piece of rock falling from chute.
Pole	30	......	1	......	Leg broken by falling rock while scaling.
Finn	27	......	1	......	Loaded car struck foot, bruising same.
Finn	22	S	1	......	Steel fell, injuring hip.
Finn	24	S	.....	1	Finger jammed while moving machinery.
Finn	22	S	1	......	Scalp cut by falling off dry wall.
Finn	25	S	1	......	Foot caught in frog and jammed by car.
English-speaking	32	S	.....	1	Slipped on ice and cut hand.
English-speaking	30	S	.....	1	Bruised by fall of sixteen feet from pipe line.
Pole	22	S	1	......	Foot bruised by car running over it.
Pole	22	S	1	......	Toe crushed by rock falling from chute.
Finn	24	S	1	......	Piece of steel fell on hand.
Pole	19	S	.....	1	Fell fifteen feet off stairway and sprained wrist.
Finn	23	S	1	......	Used carbide can for carrying water; face burned by explosion.
Finn	23	S	1	......	Piece of ore fell from chute, injuring hand.
Finn	24	S	1	......	Fell into chute and broke leg.
Russian	43	M	1	......	Pump overbalanced while moving and broke leg.
Pole	35	S	1	......	Squeezed between car and dry wall.
Finn	22	S	1	......	Finger jammed between machine and tripod.
Italian	33	M	1	......	Broken shovel handle injured hand.
Finn	21	S	1	......	Ankle sprained by piece of ore rolling down pile.
Finn	30	S	1	......	While loading car, piece of ore fell, breaking toe.
Pole	23	S	1	......	Foot bruised by piece of ore falling from chute.
Italian	30	S	1	......	Foot bruised by piece of ore falling off car.
Pole	21	S	1	......	Finger bruised while scaling.
Italian	28	M	1	......	Leg bruised by machine bar falling.
Italian	23	M	1	......	Finger bruised at chute.
Italian	26	S	.....	1	Foot injured by stepping on nail.
Finn	24	S	1	......	Body bruised by rock rolling down stope.
Finn	30	S	1	......	Body bruised by rock rolling down stope.
Austrian	24	S	1	......	Finger crushed by rock falling down stope.
Finn	23	S	1	......	Back bruised by piece of ore rolling down stope.

Table of Non-Fatal Accidents in

No.	Date of Accident.	Date of Recovery.	Name of Mine.	Name of Owner.	Name of Injured.	Occupation of Injured.
97	May 5	May 29	No. 2	Canadian Copper Co.	A. Salo	Trammer
98	" 5	" 27	Creighton	do do	A. Bassett	Drill helper
99	" 6	" 28	do	do do	M. Bilenas	Chute blaster
100	" 17	" 26	Creighton	do do	J. Sellampaa	Drill runner
101	" 17	July 3	Crean Hill	do do	J. Barscon	Drill runner
102	" 20	June 1	Creighton	do do	N. Yinkoski	Trammer
103	" 22	" 5	do	do do	V. Cleriods	Skip tender
104	" 22	" 17	do	do do	C. Maski	Trammer
105	" 23	May 31	Crean Hill	do do	P. Billy	Crusherman
106	" 26	July 15	No. 2	do do	P. Koski	Drill helper
107	" 26	June 9	Creighton	do do	F. Berarino	Trammer
108	" 31	" 15	do	do do	A. Waka	Drill runner
109	June 3	" 17	No. 2	do do	S. Waurio	Trammer
110	" 9	" 19	Creighton	do do	B. Edward	Trammer
111	" 12	" 22	do	do do	M. Anderson	Scaler
112	" 14	July 3	No.2	do do	A. Fuomi	Trammer
113	" 14	" 2	Creighton	do do	R. Salvatone	Trammer
114	" 18	" 9	No.2	do do	L. Holamas	Drill helper
115	" 19	June 30	Creighton	do do	B. Scobie	Trammer boss.
116	" 20	" 30	Crean Hill	do do	B. Zardo	Steel sharpener
117	" 20	July 28	Creighton	do do	N. Variarock	Chute tender
118	" 20	Aug. 11	do	do do	A. Leskinan	Trammer
119	" 21	" 18	do	do do	V. Godin	Drill runner
120	" 22	July 16	No.2	do do	T. Larrilla	Drill runner
121	" 23	" 2	No.3	do do	J. Prista	Crusherman
122	" 23	" 3	No.3	do do	A. Niemi	Drill runner
123	" 30	Aug. 20	No.3	do do	F. Korclitz	Trammer
124	July 3	July 22	Creighton	do do	T. Farino	Trammer
125	" 3	" 12	do	do do	S. Mohl	Trammer
126	" 7	" 21	do	do do	G. Eacinti	Trammer
127	" 8	" 17	do	do do	D. Constantini	Trammer
128	" 9	" 26	do	do do	M. Joseph	Trammer
129	" 9	" 28	do	do do	M. Antono	Drill runner
130	" 10	Sept. 1	do	do do	J. Trepoli	Trammer
131	" 18	July 29	do	do do	M. Castanzo	Trammer
132	" 18	" 31	do	do do	W. Pedlar	Level boss
133	" 18	Aug. 1	do	do do	M. Cuomo	Trammer
134	" 29	" 11	do	do do	H. Procpicijki	Drill helper
135	" 30	" 29	do	do do	H. Yuka	Drill runner
136	" 30	Nov. 5	do	do do	A. Harju	Drill runner
137	Aug. 1	Aug. 26	No. 2	do do	R. K. Paton	Surveyor
138	" 6	" 21	Creighton	do do	V. Hilka	Drill helper
139	" 7	" 26	No. 2	do do	T. Gottaneo	Laborer
140	" 11	" 20	Creighton	do do	J. Luomo	Drill runner
141	" 11	" 22	do	do do	A. Maki	Drill runner
142	" 12	" 27	do	do do	S. Monserrat	Trammer
143	" 12	" 22	do	do do	B. Domenico	Trammer
144	" 13	" 22	do	do do	E. Kivimaki	Drill runner
145	" 16	Sept. 3	No. 2	do do	O. Tobin	Trammer

or about Mines, 1913.—Continued

Nationality of Injured.	Age.	Married or single.	Below ground.	Above ground.	Nature and cause of accident.
Finn	24	S	1	......	Finger bruised by rock falling from chute.
English-speaking	25	S	1	......	Face burned by carbide lamp.
Pole	20	S	1	......	Starting chute, wrist and head cut when rock started.
Finn	32	M	1	......	Head cut by rock while scaling.
Pole	28	S	1	......	Wrist sprained while lifting machine.
Pole	28	S	1	......	Fingers bruised while dumping car.
Italian	37	M	1	......	Finger crushed while barring chute.
Pole	20	S	1	......	Foot crushed by car.
Austrian	25	S	.....	1	Foot crushed by piece of rock.
Finn	22	S	1	......	Head cut, fell twenty feet off bench when wrench slipped.
Roumanian	30	M	1	......	Foot bruised by rock falling from car.
Finn	22	S	1	......	Scaling and rock broke staging. Fell ten feet and strained back.
Finn	23	S	1	......	Walked into shaft and cut head.
Finn	24	S	1	......	Face burned by carbide lamp.
Finn	24	M	1	......	Piece of rock fell on foot while scaling.
Finn	22	S	1	......	Fingers crushed by ore falling from chute.
Spaniard	24	S	1	......	Empty car bruised leg.
Finn	21	S	1	......	Fingers pinched while placing machine on bar.
English-speaking	22	M	1	......	Fingers bruised while barring down chute.
Italian	23	S	.....	1	Hand bruised.
Pole	29	M	1	......	Foot bruised by piece of ore rolling out of chute.
Finn	35	M	1	......	Leg bruised while barring chute.
Frenchman	35	M	1	......	Wrench slipped while unscrewing pipe. Fell down stope and sprained ankle.
Finn	29	S	1	......	Arm injured while removing pump from skip.
Italian	21	S	.....	1	While barring, arm struck iron plate. The pain caused him to faint and he fell against crusher. Head cut.
Finn	22	S	1	......	Air plug blew out and cut his face.
Austrian	28	S	1	......	Hand injured by piece of ore.
Pole	26	S	1	......	Hand injured while barring chute.
Spaniard	24	S	1	......	Finger bruised by rock.
Pole	22	M	1	......	Hand bruised between car and rock.
Italian	42	M	1	......	Ankle bruised by rock rolling down pile.
Italian	45	M	1	......	Sprained back while lifting rock.
Italian	22	M	1	......	Jammed finger while tightening chuck wrench.
Spaniard	22	S	1	......	Finger jammed between car and ore.
Italian	31	M	1	......	Leg jammed between car and platform.
English-speaking	23	S	1	......	Hand jammed by rock against car.
Pole	31	S	1	......	Hand bruised when wrench slipped.
German	24	M	1	......	Hand cut while lifting rock.
Finn	22	S	1	......	Hand injured by falling ore while scaling.
Finn	26	S	1	......	Eye cut by piece of rock while scaling.
English-speaking	24	S	1	......	Fell off ladder at 9th level, striking back against guard rail.
Finn	30	S	1	......	Foot injured while setting up bar.
Italian	24	S	.....	1	Foot bruised by rock rolling on it at crusher.
Finn	24	S	1	......	Fingers crushed while setting up machine.
Finn	24	S	1	......	Head cut by falling ground, starting hole with hammer drill.
Spaniard	33	S	1	......	Foot crushed by rock while loading car.
Italian	31	M	1	......	Fingers bruised while loading car.
Finn	24	S	1	......	Foot bruised by fall of small rock in raise.
Finn	23	S	1	......	Foot caught in frog and car ran over it.

Table of Non-Fatal Accidents in

No	Date of Accident.	Date of Recovery.	Name of Mine.	Name of Owner.	Name of Injured.	Occupation of Injured.
146	Aug. 17	Sept. 5	Creighton..	Canadian Copper Co...	J. Behenna	Hoistman
147	" 21	" 26	No. 2	do do ...	E. Kantomaki	Pumpman
148	" 25	" 4	Crean Hill..	do do ...	T. Kostynyk	Crusherman
149	Sept. 1	" 15	Creighton..	do do ...	M. Zaich	Drill runner
150	" 2	" 21	do ..	do do ...	S. Guhaien	Drill runner
151	" 5	" 25	No. 2	do do ...	M. Anderson	Timberman
152	" 5	" 15	Crean Hill..	do do ...	A. Hawrylewicz..	Trammer
153	" 6	" 18	do .	do do ...	Y. Lukin	Trammer
154	" 13	" 30	No. 3	do do ...	M. Luoma	Drill runner
155	" 15	" 25	Crean Hill..	do do ...	M. Sepponen	Drill runner
156	" 16	Oct. 14	No. 2	do do ...	A. Halmi	Drill runner
157	" 23	....	No. 3	do do ...	S. Giovanni	Trammer
158	" 24	....	Crean Hill..	do do ...	B. Chorney	Trammer
159	" 24	Oct. 13	do .	do do ...	G. Naczuk	Trammer
160	" 24	Nov. 24	No. 3	do do ...	M. Vorkopan	Drill helper
161	" 25	Oct. 15	No. 3	do do ...	Y. Lakso	Trammer
162	" 27	Mar. 1	Creighton..	do do ...	J. Campice	Trammer
163	Oct. 3	Oct. 15	Creighton..	do do ...	A. Gasperoski	Drill helper
164	" 8	Dec. 18	Crean Hill..	do do ...	M. Sepponen	Drill runner
165	" 9	" 31	No. 2	do do ...	A. Selemba	Timberman
166	" 18	Nov. 10	Creighton..	do do ...	S. Lint	Scaler
167	" 19	Oct. 30	Crean Hill..	do do ...	A. Hawrylewicz..	Trammer
168	" 23	Feb. 28	No. 3	do do ...	S. Ranchink	Trammer
169	" 25	Dec. 2	Creighton..	do do ...	F. Luigi	Trammer
170	" 25	....	do ..	do do ...	M. Protzuk	Drill helper
171	" 27	Nov. 22	No. 2	do do ...	V. Kanio	Trammer
172	Nov. 3	Jan. 12	Crean Hill..	do do ...	W. Jeffery	Drill helper
173	" 3	....	Creighton..	do do ...	**L.** Condenso	Drill runner
174	" 7	Nov. 17	do ..	do do ...	C. Koreski	Trammer
175	" 10	" 25	No. 3	do do ...	S. Walpati	Trammer
176	" 14	Dec. 10	No. 3	do do ...	Y. Yusela	Drill helper
177	" 23	" 15	No. 3	do do ...	J. De Martin	Trammer
178	" 27	" 15	No. 3	do do ...	G. Artivio	Laborer
179	" 20	" 20	No. 3	do do ...	John Mumi	Drill runner
180	" 29	" 8	No. 2	do do ...	J. Toving	Skip tender
181	Dec. 4	" 15	Creighton..	do do ...	Ivan Supie	Trammer
182	" 9	" 26	do ..	do do ..	I. Grian	Trammer
	" 9	Died Mar. 21	do ..	do do ...	K. E. Olson	Timberman
	" 9	Jan. 5	do ..	do do ...	Wasyl Schlardo..	Trammer
	" 9	Dec. 29	do ..	do do ...	Geo. Doney	Drill runner
183	" 14	....	No. 3	do do ...	L. Jarvinuik	Trammer
184	" 15	Jan. 8	No. 3	do do ...	Yan Maki	Block holer
185	" 15	" 12	No. 2	do do ...	W. Kendeycwiz..	Timberman
186	" 18	....	No. 3	do do ...	Angelo Simon	Laborer
187	" 19	Jan. 19	Creighton..	do do ...	Mat. Lippinen	Drill runner
188	" 21	Feb. 3	Crean Hill..	do do ...	N. Netropka	Trammer

or about Mines, 1913.—Continued

Nationality of Injured.	Age.	Married or single.	Below ground.	Above ground.	Nature and cause of accident.
English-speaking....	25	S	.....	1	Thumb broken when throwing friction on hoist.
Finn...............	27	S	.....	1	Fingers crushed while unloading iron plates from truck.
Austrian...........	21	S	.....	1	Finger crushed in rock house.
Pole................	22	S	1	......	Arm bruised while taking down machine.
Italian.............	29	M	1	......	Thumb bruised while starting hole.
Finn...............	28	S	1	......	Head cut by piece of ore while going up manway.
Pole................	32	S	1	......	Hand crushed while loading car.
Pole................	35	S	1	......	Shoulder cut and arm bruised by rock from sand blast.
Finn...............	29	S	1	......	Foot bruised while timbering in ore pocket.
Finn...............	27	S	1	......	Foot wrenched while timbering shaft.
Finn...............	35	S	1	......	Slipped and injured shoulder while going down manway.
Italian.............	27	S	1	......	Fingers bruised while loading car.
Austrian...........	23	S	1	......	Rock fell on foot at chute.
Austrian...........	32	M	1	......	Fingers bruised while loading car.
Finn...............	28	S	1	......	Foot bruised while moving drill.
Finn...............	33	M	1	......	Foot injured by rock falling from back of drift.
Italian.............	27	M	1	......	Leg broken while dumping car at skip.
Pole................	31	M	1	......	Fingers bruised while moving machine.
Finn...............	33	S	1	......	Head cut by rock falling from back, while drilling.
Finn...............	23	S	1	......	Leg broken. Skip on which he was working in shaft broke.
Finn...............	30	S	1	......	Eye injured by premature explosion of sand blast.
Pole................	35	S	1	......	Thumb crushed while filling car at chute.
Pole................	25	S	1	......	Leg broken by piece of ore rolling down pile.
Italian.............	31	M	1	......	Fingers bruised when car dumped.
Pole................	23	S	1	......	While scaling, a piece of loose rock fell and struck foot, cutting it off below ankle.
Finn...............	28	S	1	......	Finger bruised while tramming.
English-speaking....	27	S	1	......	Foot injured by rock falling from back of drift.
Italian.............	45	S	1	......	Finger broken while tipping machine.
Pole................	24	S	1	......	Finger bruised while dumping car.
Italian.............	25	S	1	......	Leg injured by ore rolling down pile.
Finn...............	30	S	1	......	Slipped and injured head, while taking down machine.
Italian.............	24	S	1	......	Foot injured by ore rolling down pile.
Italian.............	24	S	.....	1	Leg injured while dismantling head frame.
Finn...............	32	S	1	......	Rock rolled down stope and injured foot.
Pole................	31	S	1	......	Slipped and fell into skip.
Pole..............	37	M	1	......	Squeezed between two cars.
Pole..............	22	S	1	....	Pillars Nos. 1 and 2 fell, and broke 5th level dry wall.
Swede..............	29	M	1	....	
Pole..............	22	S	1	....	
English-speaking....	36	M	1	....	
Pole..............	28	S	1	......	Finger bruised while loading car.
Finn...............	48	M	1	......	Drilled into explosive while blockholing.
German.............	35	M	1	......	Finger jammed by timber.
Italian............	26	S	.....	1	Eye injured by piece of rock.
Finn...............	31	......	1	......	Broke small bone of shoulder, while lifting a machine.
Russian............	35	M	1	....	Three fingers blown off. Experimented with explosive by lighting small piece of fuse with detonator attached.

Table of Non-Fatal Accidents

No.	Date of Accident.	Date of Recovery.	Name of Mine.	Name of Owner.	Name of Injured.	Occupation of Injured.
189	Aug. 5	Oct. 9	Long Lake Gold Mine.	Canadian Exploration Co.	E. King..........	Drill helper...
190	Sept. 20	" 27	Queensboro Mine......	Canadian Sulphur Ore Co.	J. Adams........	Drill runner..
191	May 7	....	Alexandra..	Canadian Gold and Silver Mining Co.	W. Rae..........	Trammer.....
192	" 28	Aug. 4	Chambers Ferland..	Chambers Ferland Mining Co.	D. McLeod.......	Engineer......
193	Nov. 11	Nov. 25	do	do do	G. Stingle.......	Drill runner..
194	Jan. 13	Mar. 18	Cobalt Lake	Cobalt Lake Mining Co.	M. Szalyone......	Skip tender...
195	" 22	Feb. 20	do	do do	J. Harja.........	Drill runner...
196	Ap'l 1	Ap'l 9	do	do do	A. Pelletta.......	Pipe fitter.....
197	" 11	" 21	do	do do	W. Mathieson....	Trammer......
198	Aug. 26	Sept. 6	do	do do	S. Shutva........	Drill runner..
199	Sept. 17	Totally incapa-	do	do do	J. Waller........	Drill helper...
	" 17	citated.	do	do do	J. McGregor.....	Drill runner...
200	Oct. 16	Dec. 15	do	do do	E. Putlak........	Trammer......
201	Sept. 18	Nov. 1	Townsite...	Cobalt Townsite Mining Co.	J. Devine........	Drill runner..
202	Jan. 17	Jan 29	Colonial....	Colonial Mining Co....	J. Bennetts......	Drill runner..
203	" 21	Feb. 10	do ...	do do ...	W. Chapman.....	Trammer......
204	" 30	Ap'l 4	Coniagas...	Coniagas Mines, Ltd...	J. Rochester.....	Ore sorter.....
205	Mar. 25	May 27	Crown Reserve..	Crown Reserve Mining Co.	Thos. Scott......	Mechanic......
206	Mar. 17	Jan. 3	Henderson Talc Mine	Cross and Wellington..	W. Young........	Drill runner...
207	July 23	Totally incapa-	Dane Mine.	Dane Copper Co.......	Chas. Johnson...	Contractor....
	" 23	citated.			S. Cockshutt.....	Trammer......
208	Jan. 20	Ap'l 3	Dome......	Dome Mines, Ltd......	A. Kitchen.......	Trammer boss.
209	" 25	Mar. 6	do	do do	W. Pearson......	Crusherman...
210	Feb. 26	May 5	do	do do	J. B. James......	Millman.......
211	Mar. 24	Ap'l 7	do	do do	P. Gutcher.......	Machinist.....
212	Ap'l 21	May 13	do	do do	T. Ruyich.......	Trammer......
213	" 22	" 14	do	do do	F. Krynaric......	Trammer......
214	June 11	July 17	do	do do	J. Howey........	Timberman....
215	" 18	" 1	do	do do	T. Fortune.......	Carpenter.....
216	July 2	Aug. 4	do	do do	J. Ello...........	Laborer.......
217	" 5	July 20	do	do do	J. J. Jordan.....	Mill foreman..
218	" 16	Aug. 13	do	do do	J. Berlick........	Trammer......
219	" 22	" 12	do	do do	J. Neil..........	Laborer.......
220	" 29	" 13	do	do do	U. Birnorsink....	Trammer......
221	Sept. 8	Sept. 22	do	do do	J. Snider........	Mule driver...
222	Nov. 5	Nov. 14	do	do do	K. Skoblato......	Chuteman.....
223	" 7	" 17	do	do do	R. Kruger.......	Millman.......
224	" 13	Dec. 19	do	do do	V. Hill..........	Drill runner..
225	Dec. 18	Mar. 9	do	do do	N. Novark.......	Laborer.......
226	Jan. 20	Feb. 18	Dome Lake.	Dome Lake Mining and Milling Co.	N. Zrenck.......	Trammer.....

in or about Mines, 1913.—Continued.

Nationality of Injured,	Age.	Married or single.	Below ground.	Above ground.	Nature and Cause of Accident.
Pole			1		Foot bruised by rock rolling down pile.
English-speaking			1		Car fell down shaft, injuring head and arm.
English-speaking	34		1		Timber rolled on foot.
English-speaking	19	S		1	Leg broken while helping to move tripod.
English-speaking	24		1		Fell from bucket in shaft thirty-five feet and fractured three ribs.
Pole	24		1		Bucket became detached from cable and fell down winze, carrying out lagging, which broke two of his ribs.
Pole	38	S	1		Drilled into hole containing explosive.
English-speaking	25	M		1	Steel fell, fracturing toe.
English-speaking	20	S	1		Foot caught in track and injured by loaded car.
Pole	40	S	1		Started to slide down cable in winze. Fell, severely shaken up.
English-speaking	30	M	1		Premature explosion while examining a missed hole.
English-speaking	35	M	1		
Pole	38	M	1		Drawn with car down raise, receiving scalp wound.
English-speaking	35		1		Leg fractured and ankle crushed while scaling.
English-speaking	24	S	1		While sand blasting, returned before blast went off.
English-speaking	35	S	1		Rock fell from bucket and bruised foot.
English-speaking	50	M		1	Foot caught between revolving trommel and splash board.
English-speaking				1	Arm broken by being jammed.
English-speaking	55	M	1		Leg broken by fall of talc.
English-speaking	45	M	1		Drilled into missed hole.
Pole	22	S	1		
English-speaking	25		1		Piece of ore fell from car, fracturing leg.
English-speaking	27			1	Arm mangled by pulley of conveyor belt while applying belt dressing.
English-speaking	38			1	Hand injured by being caught in friction pulley of conveyor belt.
English-speaking	20	S		1	Face burned by babbitt spurting on him.
Austrian	30	M	1		Hand crushed between rock and chute board.
Austrian	22	S	1		Foot crushed by rock falling from chute.
English-speaking	40	M	1		Two ribs broken by fall when staging broke.
English-speaking				1	Face cut by falling against axe.
Italian	18	S		1	Severely crushed while lowering tube mill gear.
English-speaking	28	S		1	Burned by arc from electric switch.
Russian	23	S	1		Toe fractured by rock rolling down pile.
English-speaking	40	M		1	Finger crushed while moving machinery.
Austrian	20	S	1		Fingers crushed while barring at chute.
Pole	21	S	1		Leg bruised, squeezed by cars.
Pole	31	M	1		Finger crushed while barring at chute.
English-speaking	23	S		1	Ankle sprained by fall off mortar block.
Finn	30	S	1		Leg injured by rock rolling down pile.
Austrian	19	S		1	Hand caught in pulley of conveyor belt.
Pole			1		Rock fell from ascending cage and cut face.

Table of Non-Fatal Accidents

No.	Date of Accident.	Date of Recovery.	Name of Mine.	Name of Owner.	Name of Injured.	Occupation of Injured.
227	May 20	June 3	Dome Lake.	Dome Lake Mining & Milling Co.	F. Dunne........	Timberman...
228	June 10	" 27	Murray.....	British America Nickel Corporation..	N. Finni.........	Drill runner..
229	Mar. 21	Ap'l 2	Nova Scotia	Dominion Reduction Co.	A. Dotynezuk....	Laborer.......
230	Nov. 17	....	Foley-O'Brien..	Foley-O'Brien, Ltd.....	R. Doyle.........	Drill helper...
231	Ap'l 24	....	Hargraves..	Hargraves Silver Mines, Ltd..........	W. Gribben......	Drill runner..
232	Feb. 1	Feb, 25	Hollinger..	Hollinger Gold Mines, Ltd.	J. Woodlefesky...	Cage tender...
233	" 13	Mar. 5	do ..	do do	M. Moses........	Laborer.......
234	" 16	" 15	do ..	do do	V. Gosti.........	Trammer......
235	Mar. 4	" 15	do ..	do do	J. Dubois........	Drill runner...
236	May 5	May 16	do ..	do do	E. Desoneau.....	Teamster......
237	" 24	June 10	do ..	do do	S. Skinner.......	Drill runner...
238	" 27	" 13	do ..	do do	G. Hemmerick...	Nipper........
239	June 11	" 20	do ..	do do	F. Barodine......	Drill runner..
240	July 25	....	do ..	do do	S. Wilcox........	Millman......
241	Aug. 6	Aug. 19	do ..	do do	P. Krustook......	Trammer......
242	Sept. 3	Sept. 29	do ..	do do	P. Ossiuck.......	Trammer......
243	" 27	Dec. 15	do ..	do do	J. Marcovitch....	Drill helper...
244	Oct. 14	Oct. 27	do ..	do do	F. Gentile........	Drill helper...
	" 14	....	do ..	do do	J. Robibero......	Drill runner...
245	Feb. 20	Mar. 2	Hudson Bay (Gowganda)	Hudson Bay Mines, Ltd.	L. Shock........	Trammer......
246	May 20	Perm'nt	Hudson Bay (Cobalt).	do do	L. Davis.........	Drill runner..
247	" 24	July 3	do	do do	I. Johnson.......	Drill runner..
248	June 5	" 5	Kerr Lake.	Kerr Lake Mining Co...	H. Morash.......	Drill runner..
249	" 6	June 18	do .	do do	N. Robar........	Foreman......
250	July 8	Aug. 23	do .	do do	N. Kurnicki......	Trammer......
251	Sept. 25	Oct. 23	Lawson....	La Rose Mines, Ltd...	N. Fredic........	Trammer......
252	Oct. 8	....	Mann......	Mann Mines, Ltd......	L. Bakanerski...	Trammer......
253	June 19	Dec. 29	McIntyre...	McIntyre Porcupine Mines, Ltd..........	N. Oraskovitsk...	Timberman....
254	Oct. 28	" 9	do	do do	A. R. Edwards...	Electrician....
255	Jan. 6	Jan. 28	McKinley-Darragh..	McKinley-Darragh-Savage Mines, Ltd...	R. Horne........	Drill helper...
256	Mar. 10	Ap'l 12	do	do do	N. Bojco.........	Nipper........
257	Aug. 21	Sept. 2	do	do do	F. McNamara....	Drill runner..
258	Jan. 17	Jan. 27	Miller Lake O'Brien..	Miller Lake O'Brien Mines	F. Fransel.......	Foreman......
259	May 1	June 9	do	do do	P. Karulenski....	Trammer......
260	June 9	Aug. 9	do	do do	W. Melville......	Foreman......
261	Sept. 1	Sept. 29	do	do do	W. Kermode.....	Drill runner.

in or about Mines, 1913.—Continued.

Nationality of Injured.	Age.	Married or single.	Below ground.	Above ground.	Nature and Cause of Accident.
English-speaking	38	M	1		Fell twenty feet and strained shoulder when sprague slipped.
Finn	38	S	1		Finger broken by being pinched between rocks.
Pole	40			1	Leg bruised by cam shaft rolling on him.
English-speaking	28	M	1		Eyes injured by picking into powder in broken ore.
English-speaking			1		Foot was crushed by falling rock while scaling.
Pole	31		1		Struck by rock falling down shaft.
Assyrian	43			1	Ribs fractured by being struck by falling tree.
Italian	37		1		Right arm broken by being caught between cars.
English-speaking	50	M	1		Fell across support of staging and broke rib.
English-speaking	17	S		1	Fell from wagonload of wood and shoulder injured.
English-speaking	26	M	1		While carrying lagging, slipped and broke clavicle.
English-speaking	22	S	1		Attempted to board moving cage.
Italian	24	S	1		Struck on eye by bar while barring chute.
English-speaking	50	S		1	Sight of one eye destroyed by whitewash under pressure.
Austrian	35	M	1		Finger crushed between car and chute.
Russian	46	M	1		Finger crushed between car and cage.
Pole	21	S	1		Knee and spine injured when cage dropped.
Italian	24	S	1		Picked into detonator or dynamite in broken ore.
Italian	26	S	1		
Pole	50		1		Injured in explosion due to drilling into missed hole.
English-speaking	30		1		Lost sight of both eyes through drilling into cutoff hole.
Finn	30		1		Struck by falling rock and skull fractured while scaling.
English-speaking	45	M	1		Received scalp wounds in fall from chain ladder.
English-speaking	47	M	1		Struck by rock while examining stope.
Pole	24	S	1		Crushed by fall of rock from hanging wall.
Austrian	35		1		Caught between shaft timber and cage and leg bruised.
Russian	28		1		He fell forty-two feet down shaft while trying to prevent fall of loaded bucket. Thigh, wrist and ribs broken.
Russian			1		Slipped on turn plate and broke leg while unloading timber.
English-speaking	39	M	1		Standing in manway with hand on cage guides when cage came up.
English-speaking	19	S	1		While running ahead of car, slipped and wheel ran over foot.
Russian	26		1		Injured arm while riding on cage with steel.
English-speaking	28	S	1		Head bruised while scaling.
English-speaking			1		Arm injured while riding on cage.
Pole	45	M	1		Wrist sprained by being jammed between car and pipe.
English-speaking	28	S	1		Hand blown off while removing powder from hole.
English-speaking	26		1		Fell while scaling in shaft.

Table of Non-Fatal Accidents

No.	Date of Accident.	Date of Recovery.	Name of Mine.	Name of Owner.	Name of Injured.	Occupation of Injured.
262	Oct. 30	Dec. 29	Miller Lake O'Brien	Miller Lake O'Brien Mines	J. Philion........	Drill runner...
263	Feb. 20	May 19	Garson.....	Mond Nickel Co.......	W. Uhlanioy.....	Trammer......
264	Mar. 1	Ap'l 10	do	do	P. Chis..........	Trammer......
265	April 2	May 2	do	do	T. Tall..........	Drill helper...
266	" 23	....	Victoria....	do	A. Matson.......	Drill runner...
267	June 30	July 14	Garson.....	do	J. Drummond....	Machinist.....
268	July 20	....	North Star.	do	A. Chauric.......	Drill runner..
269	Sept. 8	Sept. 21	do .	do	C. Silampi.......	Drill runner..
270	Oct. 20	....	Worthington	do	N. Barcouch.....	Drill runner..
271	Nov. 20	Dec. 24	North Star.	do	T. Ojreck........	Drill helper...
272	Dec. 4	....	Garson.....	do	O. Capink........	Trammer......
273	Jan. 11	Mar, 1	Moose Mountain.	Moose Mountain Mines, Ltd..........	J. Farak.........	Hoistman.....
274	July 1	Oct. 13	do .	do do	R. Sturgeon......	Millman.......
275	Sept. 21	....	do .	do do	P. Alvano........	Drill runner..
276	" 20	Nov. 26	do .	do do	B. Carlo..	Trammer......
277	Nov. 3	,, 17	do .	do do	B. Baruyne......	Trammer......
278	Jan. 5	Jan. 21	Nipissing...	Nipissing Mining Co...	L. Gaspari.......	Millman.......
279	Mar. 24	Ap'l 23	do ..	do do ...	J. Trottier.......	Laborer.......
280	" 28	" 11	do ..	do do ...	E. Bellanger.....	Drill runner...
281	April 5	....	do ..	do do ...	D. Hammond....	Millman.......
282	" 13	Sept. 8	do ..	do do ...	E. Ayotte........	Pumpman.....
283	" 18	May 13	do ..	do do ...	W. Majdam......	Trammer......
284	" 19	" 2	do ..	do do ...	F. Koloski.......	Drill helper...
285	Aug. 9	Aug. 24	do ..	do do ...	J. McGregor.....	Mill foreman..
286	Sept. 29	Oct. 20	do ..	do do ...	G. Vellonois......	Trammer......
287	Feb. 9	Mar. 3	Northern Customs..	Northern Customs Concentrator	W. Bennett......	Millman.......
288	Mar. 4	....	do .	do do	F. Capitano......	Laborer.......
289	Nov. 17	Dec. 15	do .	do do	E. Boyce.........	Carpenter.....
290	May 16	June 1	Northern Pyrites...	Northern Pyrites Co...	O. Wilson........	Drill runner...
291	Aug. 30	Oct. 11	do	do do ...	M. Fedyszyn.....	Trammer......
292	Nov. 6	Permanently Incap'ed	do	do do ...	E. Kaartinen.....	Drill helper...
293	Jan. 30	Mar. 1	O'Brien..	M. J. O'Brien.........	E. Smith.........	Drill helper...
294	Sept. 9	Oct. 10	do	do	R. Goldsworthy..	Drill helper...
295	Dec. 15	Jan. 13	do	do	M. Dolyrunick...	Cage tender...
296	Jan. 24	Feb. 9	Penn-Canadian.	Penn-Canadian Mines..	T. Osborne	Drill-runner ..
297	July 7	July 30	do	do do	F. Babaneo	Drill-runner ..
298	Aug. 25	Sept. 30	do	do do	W. Janes	Machinist ...
299	Dec. 9	Dec. 26	do	do do	A. Haapala	Trammer ....
300	May 8	May 19	Peterson Lake.....	Peterson Lake Silver	H. Wilcox	Drill-runner ..
301	Aug. 26	Sept. 6	do .	Cobalt Mining Co. ...	J. McGuire	Foreman ....
302	May 1	May 12	Right of Way.....	Right of Way Mines Co.	A. Agmoinin ...	Drill-runner ..

in or about Mines, 1913.—Continued.

Nationality of Injured.	Age.	Married or single.	Below ground.	Above ground.	Nature and Cause of Accident.
English-speaking....	30	......	1	......	Finger injured while moving drill.
Pole................	24	S	1	......	Struck by flying rock when another workman drilled into missed hole.
Pole................	....	......	1	......	Right leg broken, due to cage falling a few feet.
Finn................	....	S	1	......	Slipped and fell twenty-five feet when tightening up jack screw.
Finn................	25	M	1	......	Forearm broken by rock falling from rock pentice.
English-speaking....	24	S	.....	1	Ribs broken by fall when pipe-tongs broke.
Finn................	24	S	1	......	Skull fractured by fall of small piece of ore in west pit.
Finn................	....	......	1	......	Premature explosion, due to untamped hole.
Pole................	27	S	1	......	Bruised from fall when staging in shaft broke.
Roumanian.........	36	S	1	......	Head cut while scaling.
Pole................	33	M	1	......	Leg broken by piece of ore rolling down pile.
	....	......	.....	1	Held lighted cigarette to end of detonator.
English-speaking....	30	......	.....	1	Arm crushed while applying belt dressing to conveyor belt.
Finn................	....	......	1	......	Leg broken; fell from bench in glory hole.
Italian..............	....	......	1	......	Knee torn by rock loosened by driller above him.
Pole................	....	S	1	......	Rib broken by rock from chute.
Italian..............	....	......	.....	1	Finger amputated by being caught by scoop of tube mill.
English-speaking....	20	S	.....	1	Foot injured by rock from chute in rock house.
English-speaking....	33	M	1	......	Toe bruised by falling rock.
English-speaking....	28	S	.....	1	Solution in high grade mill splashed in eye.
English-speaking....	40	M	1	......	Leg broken when cage dropped.
Austrian............	22	S	1	......	Foot bruised by car.
Russian............	22	S	1	......	Foot crushed by rock.
English-speaking....	26	M	.....	1	Thumb crushed at tube mill.
Italian..............	26	......	.....	1	Foot crushed while dumping car.
English-speaking....	30	......	.....	1	Burned by splash of zinc.
Italian.............	37	......	.....	1	Head cut by being struck by handle of winch.
English-speaking....	38	M	.....	1	Scaffold collapsed; fell fourteen feet and landed on stump.
English-speaking....	....	......	1	......	Two ribs broken by fall of hammer drill.
Pole................	....	......	.....	1	Hand caught between sheave and cable at terminal.
Finn...............	23	S	1	......	Struck by fall of ore in stope, back broken.
English-speaking....	....	......	1	......	Fell from staging in stope and fractured two ribs.
English-speaking....	22	......	1	......	Collar-bone broken by piece of falling rock.
Austrian...........	23	......	1	......	Back injured when cage dropped.
English-speaking ...	23	S	1	......	While sledging rock piece flew in his eye.
Italian	25	M	1	......	Hand caught between drill and back of drift.
English-speaking ...	39	M	.....	1	Fell against wall and injured leg.
....	....	......	1	......	Piece of rock fell, injuring head and shoulder.
English-speaking ...	22	S	1	......	While sledging rock piece cut hand.
English-speaking ...	....	......	1	......	Rail fell on foot, bruising same.
Italian	27	S	1	......	Foot injured by rock while scaling.

Table of Non-Fatal Accidents

No.	Date of Accident.	Date of Recovery.	Name of Mine.	Name of Owner.	Name of Injured.	Occupation of Injured.
303	May 16	May 26	Right of Way	Right of Way Mines Co.	J. Consol	Trammer
304	Jan. 30	Mar. 24	Temiskaming	Temiskaming Mining Co.	D. McDougall	Timberman
305	Feb. 6	Feb. 18	do	do do	J. Smuk	Nipper
306	June 16	July 2	do	do do	D. McInnis	Drill-runner
307	Aug. 4	Sept. 6	Tough-Oakes	Tough-Oakes Gold Mines	P. Sampson	Drill-runner
308	May 1	....	Trethewey	Trethewey Silver Cobalt Mine, Ltd.	H. Lewis	Drill-runner
309	" 19	....	do		N. Thopolnitski	Trammer
310	June 12	June 23	do	do do	J. Gondman	Millman
311	July 11	July 31	do	do do	J. Guinta	Trammer
312	Sept. 20	Oct. 25	do	do do	G. Dunn	Timberman
313	June 21	....	U. S. Cobalt Mine	United States Cobalt Mining Co.	T. Robyk	Trammer
314	Sept. 25	Oct. 25	York Ontario	York Ontario Silver Mines, Ltd.	O. Julio	Drill-runner

In or about Mines, 1913.—Continued.

Nationality of Injured.	Age.	Married or single.	Below ground.	Above ground.	Nature and Cause of Accident.
Italian	31	S	1	......	Rock fell while loading car, injuring foot.
English-speaking	....	......	1	......	Rock fell from chute and broke toe.
Austrian	30	......	1	......	Tripped over sprague and fell down stope.
English-speaking	30	S	1	......	Fell from staging due to sprag giving way.
English-speaking	34	......	1	......	Fell from ladder while lowering stull.
English-speaking	25	S	1	......	Used carbide drum for carrying water, explosion burnt face.
Austrian	30	......	1	......	Fingers crushed while dumping car.
English-speaking	25	S	.....	1	Foot bruised when pulley fell.
Pole	....	......	1	......	Toe fractured by rock falling from car.
English-speaking	20	S	1	......	Skull fractured when timber slipped.
Pole	37	......	1	......	Arm broken when hose blew off.
English-speaking	26	S	1	......	Picked into detonator or small piece of powder.

Accidents at Metallurgical Works.

The metallurgical works which come under the Mining Act of Ontario include blast furnaces, copper-nickel smelters and converter plants, silver smelters and acid plants. At these works during 1913 eleven fatal accidents occurred, causing the death of eleven workmen, compared with ten fatalities in 1912. Five of these fatalities occurred at blast furnaces, five at copper-nickel smelters and converter plants, one at acid works. There were no fatalities at the silver smelters. Ten occurred during the first six months of the year and one during the latter half.

At the blast furnaces one fatality during the year was due to gas, compared with five during 1912. Nearly all the blast furnaces are now equipped with pulmotors, and it is hoped that the use of this apparatus at such works will decrease the gassing fatalities.

Of the five fatalities which occurred at copper-nickel smelters during the year, four were accidents in connection with transportation operations in the yards. Owing to the noise, the short hauls, the backing in and out of buildings, and the escaping steam, especially during the winter months, this work is particularly dangerous.

In addition to the fatalities, 201 serious accidents occurred at metallurgical works as compared with 122 during 1912.

On February 10th, an Italian brakeman was injured on the charge floor at the smelter of the Canadian Copper Company, when one of a train of eight cars left the rails. He was crushed about the hips, and died the next day. He was riding between the cars contrary to the orders of the Company.

On February 8th an Italian laborer in the smelter yards of this Company slipped and struck his head against the side of a coal car. He continued work until February 18th, but died February 20th. A post-mortem showed a clot of blood on the left side of the brain and that the part of the skull where the blow was received was only 1-16 inch in thickness.

On February 20th an Italian track laborer was struck by a train backing out of the converter building of the Canadian Copper Company. He had just thrown a switch for a slag train and stepped back when he was struck by the other train and killed.

On April 3rd an English brakeman was killed in the smelter yards of the same company. He was riding on the foot-board of the tender, fell between the locomotive and the tender, and was dragged 150 feet before he was noticed.

On April 28th, a Polish baleman was killed by being splashed with hot matte when a link in the bale of a crane carrying a ladle of matte broke. This break was due to a defective weld which could not be detected by an exterior examination.

On March 18th an Austrian laborer was found gassed in the salt room of the blast furnace of the Algoma Steel Corporation. The doctor who made the post-mortem examination stated that death was due to suffocation following a hemorrhage in the walls of the stomach. The body showed flushing indicative of carbon-monoxide poisoning.

On May 21st, T. J. Brewster, aged 17, a fireman on a crane in the yards of the Canada Iron Corporation, was crushed to death between the platform and moving frame of the hoist. The jury in the verdict recommended that persons of more mature years be employed for such work.

On February 6th a negro furnace keeper was killed at the blast furnace of the Canada Iron Corporation, while helping to pull a mud gun which was frozen in the notch of No. 2 furnace. The nozzle was suddenly released, and the bar which he was holding struck him on the temple.

On May 10th, an electrician was killed at the blast furnace of The Steel Company of Canada while replacing a dead light on a 220-volt line. He was standing on a ladder, and probably received a shock which caused him to fall a distance of 12 feet, crushing his skull against the brick floor.

On November 14th, an oiler in the engine room of the Canada Furnace Company was killed when the exhaust chamber of a steam turbine blew out. He had neglected to open the exhaust before starting up the machine.

On June 5th a laborer employed in the salt cake mill of the Nichols Chemical Company, Sulphide, was killed by being caught in a pulley belt. How the accident happened could not be explained at the inquest.

The occupation and nationality of the men who were killed are shown in the following table:—

Occupation.	English speaking.	Italian.	Pole.	Austrian.	Total.
Laborer	....	2	1	....	3
Brakeman	1	1	....	....	2
Baleman	....	....	....	1	1
Mechanic	1	....	....	....	1
Furnace keeper	1	....	....	....	1
Fireman	1	....	....	....	1
Foreman	1	....	....	....	1
Electrician	1	....	....	....	1
Total	6	3	1	1	11

The ages of the men killed at metallurgical works were as follows:—

17–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	Total.
1	0	4	3	0	1	1	1	11

Cause and Place of Fatalities.

	1912.	1913
Blast Furnaces:—		
Asphyxiation from furnace gas	4	1
Breaking of scaffold	1	0
Electrocution	1	1
Lining of furnace falling	1	0
Crushed between crane platforms	0	1
Struck by bar of mud gun	0	1
Struck by broken machinery	0	1
	7	5
Copper-Nickel Smelters and Converter Plants: —		
Struck by train	1	3
Crushed by rabbles	1	0
Struck by falling plank	1	0
Fell and struck head	0	1
Burned by spilled matte	0	1
	3	5
Acid Plant:—		
Caught in machinery	0	1
	0	1
Total	10	11

Causes of Non-Fatal Accidents at Metallurgical Works

The following schedule shows the causes of the non-fatal accidents in 1913, at the metallurgical works, and the number injured:—

Burned	40
Falling objects	33
Falling from elevated places	22
Slipped and fell	19
Caught by machinery	16
Injured by cars	16
Crushed between two objects	13
Cut by slag, matte, etc.	10
Struck by hammer	7
Foreign substance in eye	5
Miscellaneous	20
Total	201

In the Subjoined Table is Given the Occupation and Nationality of the Men Injured in Metallurgical Works.

Occupation.	English speaking.	Italian.	Pole.	Finn.	Austrian	German.	Swede.	Roumanian.	Total.
Laborer	11	62	37	4	5			1	120
Foreman	4	2							6
Repair man	1								1
Stove tender	1								1
Furnace keeper		1	5						6
Mechanic	1	1							2
Pipe Fitter	11			4					15
Water Tender	1	1							2
Furnace Helper	3	3	2						8
Pourer		3							3
Furnace Blower	2								2
Millwright	2								2
Engineer	5								5
Tapper		1		2		1			4
Lineman	1								1
Brakeman	4		2						6
Mason		1							1
Motorman		1							1
Carpenter	4		1				1		6
Blacksmith	1								1
Skimmer	1								1
Tuyere Puncher			3						3
Teamster	1								1
Feeder			1						1
Electrician	1								1
Cupeller		1							1
Totals	55	77	51	10	5	1	1	1	201

The ages of the injured men were as follows:

17 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51–60	Unknown.	Total.
22	48	55	32	21	8	4	5	6	201

Table of Fatal Accidents at

Number.	Date 1913.	Name of Works.	Name of Owner.	Name of Deceased.	Occupation of Deceased.
1	March 18	Blast Furnace	Algoma Steel Co	John Volumick	Laborer
2	Feb. 10	Smelter Yard	Canadian Copper Co.	Giovanni Pietro	Brakeman
3	" 8	do	do do	E. Domenico	Laborer
4	" 21	do	do do	P. Guisseppi	Laborer
5	April 3	do	do do	Chas. Hough	Brakeman
6	" 28	Smelter	do do	Mike Buchowski	Bale man
7	Nov. 14	Power Plant	Canadian Furnace Co.	J. H. Bruce	Mechanic
8	Feb. 6	Blast Furnace	Canada Iron Corp'n	Robt. Connolly	Furnace keeper.
9	May 21	Smelter Yard	do do	Thos. J. Brewster	Fireman
10	June 5	Acid Works	Nichols Chemical Co.	Louis Lavallee	Foreman
11	May 10	Blast Furnace	Steel Co. of Canada	J. Selkirk	Electrician

Metallurgical Works, 1913.

Nationality of Deceased.	Age.	Married or Single.	Above ground.	Nature and Cause of Accident.
Pole	32	S	1	Asphyxiated in salt room.
Italian	27	S	1	Injured while shunting cars.
Italian	27	M	1	Fell and struck head against rail; died Feb. 20.
Italian	55	M	1	Stepped on track ahead of shunting engine.
English-speaking.	27	S	1	Fell from tender under wheels of locomotive.
Austrian	30	S	1	Burned by spilled matte, when link holding ladle broke.
English-speaking.	33	M	1	Head of exhaust chamber steam turbine generator blew out.
Negro	42	M	1	Struck on head by bar, when mud gun suddenly released.
English-speaking.	17	S	1	Crushed between crane platforms.
English-speaking.	35	M	1	Clothing caught in shafting.
English-speaking.	50	M	1	Electrocuted while repairing lamp.
Total	......	......	11	

Table of Non-Fatal Accidents

No.	Date of Accident.	Date of Recovery.	Name of Works.	Name of Owner.	Name of Injured.	Occupation of Injured.
1	Jan. 10	Feb. 21	Blast Furnace..	Algoma Steel Corporation.......	Gutano Stocco....	Laborer.......
2	" 13	Jan. 21	do ...	do do	G. Marsino.......	Laborer.......
3	" 27	Feb. 10	do ..	do do	R. Primo.........	Laborer.......
4	Feb. 1	" 10	do ..	do do	Wm. Coatby......	Foreman......
5	Feb. 1	" 14	do ..	do do	P. Sacripanti.....	Laborer.......
6	" 5	" 16	do ..	do do	V. Grabowski....	Laborer.......
7	" 6	" 16	do ..	do do	G. Pasianita......	Laborer.......
8	" 16	Mar. 1	do ...	do do	M. Butkovic......	Laborer.......
9	" 23	....	do ..	do do	S. Paluck........	Laborer.......
10	Mar. 8	Mar. 20	do ..	do do	J. Maslyk........	Laborer.......
11	" 9	" 26	do ..	do do	Frank Kolic......	Laborer.......
12	" 10	" 18	do ..	do do	Gordon Wilson...	Repair man....
13	" 10	" 19	do ..	do do	M. Atkinson......	Stove tender...
14	" 22	April 3	do ..	do do	Joseph Fis.......	Keeper........
15	" 24	" 4	do ..	do do	S. Socla..........	Laborer.......
16	" 26	" 14	do ..	do do	J. Jasansky......	Keeper........
17	April 2	" 14	do ..	do do	T. E. Bell........	Mechanic......
18	" 12	May 5	do ..	do do	S. Walicki.......	Keeper........
19	" 29	" 8	do ..	do do	S. Gawant.......	Helper........
20	May 5	" 13	do ..	do do	Peter Korah......	Helper........
21	" 12	" 26	do ..	do do	J. Wornort.......	Laborer.......
22	" 17	....	do ..	do do	Henry Knox.....	Pipe fitter.....
23	June 3	June 13	do ..	do do	M. Longo........	Water tender..
24	" 6	" 15	do ..	do do	R. Bolechione....	Laborer.......
25	" 14	" 21	do ..	do do	Kelly Ely........	Pipe fitter.....
26	" 20	" 28	do ..	do do	G. Pasianito.....	Laborer.......
27	" 29	July 14	do ..	do do	Yam Birloska....	Helper........
28	" 29	" 14	do ..	do do	Joe Pettenuso....	Fireman......
29	July 12	" 20	do ..	do do	Ed. Lawler.......	Pipe fitter.....
30	" 22	Aug. 2	do ..	do do	Herb. Hamilton..	Water tender..
31	" 25	" 4	do ..	do do	Paul Rsepa.......	Laborer.......
32	" 27	" 17	do ..	do do	P. Sacripanti.....	Pourer........
33	Aug. 27	Oct. 30	do ..	do do	W. Sczesny.......	Helper........
34	Sept. 5	" 6	do ...	do do	Kelly Ely........	Pipe fitter.....
35	" 5	Sept. 29	do ..	do do	A. Golassi.......	Laborer.......
36	" 18	....	do ..	do do	G. Luni..........	Laborer.......
37	" 23	Oct. 5	do ..	do do	G. Colabianchi...	Keeper........
38	Oct. 4	" 27	do ..	do do	D. Nigus.........	Laborer.......
39	" 9	Dec. 22	do ..	do do	R. Errington.....	Laborer.......
40	" 21	Oct. 29	do ..	do do	P. Sabatino......	Pourer........
41	" 21	" 28	do ...	do do	A. Digasparo.....	Foreman......
42	Nov. 11	Nov. 19	do ..	do do	S. Sniezek.......	Keeper........
43	" 19	....	do ..	do do	B. Sacrapenti....	Pourer........
44	" 30	Jan. 2	do ..	do do	R. Zorzi.........	Laborer.......
45	Dec. 9	" 15	do ..	do do	Ed. Lawler.......	Blower........
46	" 13	Dec. 29	do ..	do do	Jas. Nicholson...	Millwright....
47	" 21	" 30	do ..	do do	J. Jasensky......	Keeper........
48	Jan. 7	Jan. 20	Smelter........	Canadian Copper Co...	P. Elspidia......	Laborer.......
49	" 8	Feb. 26	do	do do	J. Latasky.......	Laborer.......
50	" 10	Jan. 26	do	do do	H. Jackson......	Engineer......
51	" 16	" 24	do	do do	W. Todman......	Fitter.........
52	" 17	Feb, 3	do	do do	F. Seneridye.....	Laborer.......
53	" 18	" 13	do	do do	T. Emilio........	Tapper.......
54	" 18	" 24	do	do do	T. Pietro........	Laborer.......

at Metallurgical Works, 1913.

Nationality of Injured.	Age.	Married or single.	Number injured.	Nature and Cause of Accident.
Pole................	18	S	1	Bucket of scrap swung around and struck foot, breaking toe.
Italian.............	22	S	1	Struck on head by falling bar.
Italian.............	20	S	1	Slipped and fell between two cars, bruising neck.
English-speaking....	....	M	1	Slipped into hole and sprained ankle.
Italian..............	32	M	1	Iron in mould exploded and burned hand.
Italian.............	29	S	1	Eye burned while pulling bar out of iron notch.
Italian..............	29	S	1	Particle of cinder blown in eye.
Austrian............	18	S	1	Splash from iron struck him in eye.
Italian.............	38	......	1	Fell from platform and broke collar-bone.
Pole................	38	......	1	Fell and cut eye.
Pole................	45	......	1	Iron splashed and burned neck when lifting gate.
English-speaking....	....	M	1	Jack screw broke and cylinder fell on him, cutting lip.
English-speaking....	26	S	1	Bar slipped and struck him in stomach.
Pole................	25	S	1	Hand burned by hot iron.
Pole................	45	M	1	Cut finger on wheelbarrow.
Pole................	25	S	1	Collar on cooler broke, crushing finger.
English-speaking....	38	M	1	Weight fell on finger, breaking it.
Pole................	22	S	1	Leg burned while tapping furnace.
Pole................	28	S	1	Finger cut by sheet iron.
Austrian............	....	M	1	Wrenched shoulder while drilling iron notch.
Pole................	22	S	1	Foot bruised by piece of cinder dropped from crane.
English-speaking....	20	S	1	Finger jammed while repairing pump.
Italian..............	25	S	1	Foot scalded while blowing out boiler tubes.
Italian..............	19	S	1	Piece of scrap fell off barrow on foot.
English-speaking....	25	M	1	Balance weight fell on foot.
Italian..............	32	M	1	Lever fell on foot, bruising same.
Pole................	20	S	1	Right arm and side burned; iron blew out of notch.
Italian..............	22	S	1	Struck by piece of scrap and ankle sprained.
English-speaking....	30	M	1	Hand cut while changing tuyere.
English-speaking....	19	S	1	Fell from bussel pipe while gassed.
Pole................	30	M	1	Foot bruised by chain falling on it.
Italian..............	25	S	1	Burned on back and hips by splashed iron.
Pole................	21	S	1	Forearm burned by falling penstock.
English-speaking....	25	M	1	Fell from platform and cut skull.
Italian.............	26	S	1	Furnace slipped and hot stock burned head and hand.
Italian..............	44	M	1	Foot burned while cleaning out hearth.
Italian..............	23	S	1	Badly burned while drilling out iron notch.
Italian..............	18	S	1	Furnace slipped and splashed metal in face.
English-speaking....	25	S	1	Slipped from gangway and sprained ankle.
Italian.............	22	S	1	Eye burned by spark of hot metal.
Italian.............	25	M	1	Hand crushed between cars.
Pole................	....	M	1	Eye injured by spark of iron.
Italian.............	26	S	1	Metal splashed on foot.
Italian.............	38	M	1	Fell from car and sprained wrist.
English-speaking....	31	M	1	Puller slipped and injured head.
English-speaking....	55	M	1	Head injured by falling wedge.
Pole................	46	M	1	Foot burned while drilling out notch.
Italian............	19	S	1	Fell from gangway and injured side.
Pole..............	29	S	1	Foot jammed between motor and rail.
English-speaking....	30	M	1	Leg sprained by jumping from cab to escape slag.
English-speaking....	32	S	1	Fell into elevator pit and injured leg.
Pole..............	19	S	1	Slipped on ice and cut hand.
Italian..............	32	M	1	Burned through leakage from tuyere.
Italian..............	46	M	1	Fell on ice and injured ankle.

Table of Non=Fatal Accidents at

No.	Date of Accident.	Date of Recovery.	Name of Works.	Name of Owner.	Name of Injured.	Occupation of Injured.
55	Jan. 23	Feb. 3	Smelter........	Canadian Copper Co.............	E. Johnston.....	Fitter.........
56	" 29	" 17	do	do do	P. Luigi.........	Mason........
57	" 30	" 18	do	do do	W. Light........	Engineer......
58	Feb. 3	" 12	do	do do	B. Enrico........	Laborer.......
59	" 3	" 12	do	do do	G. Davidson.....	Laborer.......
60	" 4	" 12	do	do do	Z. Guiseppe......	Laborer.......
61	" 6	June 23	do	do do	J. B. Wylie......	Lineman......
62	" 11	May 12	do	do do	G. Cassidy.......	Brakeman.....
63	" 11	Feb. 24	do	do do	M. Diku.........	Laborer.......
64	" 12	Mar. 12	do	do do	S. Sarcangello...	Laborer.......
65	" 15	" 24	do	do do	F. Luigi.........	Laborer.......
66	" 17	" 31	do	do do	F. Switch........	Foreman......
67	" 18	" 2	do	do do	C. Metro.........	Brakeman.....
68	" 21	" 10	do	do do	F. Ludivina.....	Laborer.......
69	" 26	Ap'l 14	do	do do	D. Paterina......	Laborer.......
70	" 26	Mar. 6	do	do do	C. Eugenio.......	Laborer.......
71	" 27	" 28	do	do do	C. Grossatto.....	Laborer.......
72	" 28	" 11	do	do do	B. Antonio......	Laborer.......
73	Mar. 1	" 13	do	do do	J. Pytyle........	Laborer.......
74	" 5	Ap'l 21	do	do do	J. Boiullia.......	Motorman.....
75	" 5	Mar. 18	do	do do	P. Twanschak...	Laborer.......
76	" 5	" 25	do	do do	J. Koreski.......	Laborer.......
77	" 8	" 16	do	do do	P. Rogass........	Laborer.......
78	" 16	" 24	do	do do	T. Vittorio.......	Laborer.......
79	" 18	" 31	do	do do	G. Lingraine.....	Laborer.......
80	" 19	" 31	do	do do	M. Oskrowske....	Laborer.......
81	" 19	April 2	do	do do	C. Angelo........	Laborer.......
82	" 19	May 14	do	do do	C. Luigi.........	Laborer.......
83	" 20	Ap'l 14	do	do do	N. Laurie.......	Fitter.........
84	" 21	" 1	do	do do	G. Miller.........	Brakeman.....
85	" 21	" 7	do	do do	W. Boyd........	Foreman......
86	" 21	Mar. 29	do	do do	L. Bacowski.....	Carpenter.....
87	" 10	Ap'l 14	do	do do	J. Oksalo........	Fitter.........
88	" 14	Mar. 31	do	do do	D. Finn.........	Tapper........
89	" 25	Ap'l 3	do	do do	T. Antonio......	Laborer.......
90	" 28	" 14	do	do do	G. Hudson.......	Blacksmith....
91	Ap'l 3	" 21	do	do do	M. Enrico.......	Laborer.......
92	" 3	" 24	do	do do	R. Calomini.....	Fitter.........
93	" 4	July 9	do	do do	D. Angelo.......	Laborer.......
94	" 5	Ap'l 15	do	do do	A. Waulff........	Skimmer......
95	" 15	" 28	do	do do	T. Edyvear......	Fitter.........
96	" 16	May 2	do	do do	J. Robertson.....	Helper........
97	" 16	Ap'l 23	Crushing plant.	do do	G. Bojuk.........	Laborer.......
98	" 21	May 1	Smelter........	do do	P. Dykonicki....	Laborer.......
99	" 22	Oct. 1	Roast yard.....	do do	J. Papaluka......	Laborer.......

Metallurgical Works, 1913.—Continued.

Nationality of Injured.	Age.	Married or single.	Number injured.	Nature and cause of accident.
English-speaking	30	S	1	Hand drawn into drill and fingers injured.
Italian	27	S	1	While carrying plank fell and sprained back.
English-speaking	23	S	1	Cut wrist on glass while washing cab windows.
Italian	27	S	1	Struck by timber while loading car.
English-speaking	19	S	1	Eye burned by explosion of matte.
Italian	25	S	1	Piece of timber fell on foot while loading boiler.
English-speaking	29	S	1	Fell from top of pole to ground, due to receiving shock.
English-speaking	30	M	1	While getting down from tender of locomotive slipped and fell between tender and car and leg amputated.
Pole	39	M	1	Piece of matte he was carrying fell on his foot.
Italian	24	S	1	Piece of slag shell from pot rolled on foot.
Italian	32	S	1	Fell out of car and injured back.
English-speaking	33	M	1	Fell from car as it was being shunted and injured hip and head.
Pole	19	S	1	Struck by locomotive and legs bruised.
Italian	23	S	1	Fell on ice and bruised arm.
Italian	28	S	1	Foot caught between brakebeam and car truck.
Italian	42	M	1	Fell and sprained wrist.
Italian	27	S	1	Matte exploded as it was being poured and foot burned.
Italian	56	S	1	Sprained back while putting car on track.
Pole	37	M	1	Foot burned while pouring ladle of matte.
Italian	36	S	1	Motor collided with car and hand cut.
Pole	27	S	1	Hand caught in chain of coal belt and thumb cut.
Pole	37	S	1	Hand injured by slag pot.
Pole	23	S	1	Foot burned by slag.
Italian	35	S	1	Head came off hammer and struck his side.
Italian	19	S	1	Hand injured by piece of coke falling on it.
Pole	22	S	1	Head burned by explosion while breaking skull.
Italian	31	......	1	Foot bruised by iron plate falling on it.
Italian	31	......	1	Foot bruised by pipe falling on it.
Finn	26	S	1	Finger jammed between plates.
English-speaking	18	S	1	Leg jammed between motor and car.
English-speaking	49	M	1	Slipped and sprained ankle.
Pole	32	......	1	Slipped and sprained ankle.
Finn	37	M	1	Finger amputated by being caught between door and side of furnace.
Finn	37	M	1	Heel burned by matte while tapping furnace.
Italian	26	S	1	Explosion occurred while shelling slag pot.
English-speaking	31	M	1	Scale of hot iron struck hand.
Italian	32	S	1	While unloading steel chute from car it slipped and struck him.
Finn	28	S	1	Fingers jammed while connecting pipe line.
Italian	29	M	1	Slipped on ice and injured hip.
English-speaking	26	M	1	Fell through skimming hole in converter floor.
English-speaking	28	S	1	Eyes injured by dust from furnace valve.
English-speaking	27	S	1	Finger jammed by boiler plate.
Pole	35	S	1	Fell from car.
Pole	23	S	1	Fingers injured in gears of slag pot.
Pole	26	S	1	Struck by ties and leg broken when engine struck car.

Table of Non-Fatal Accidents at

No.	Date of Accident.	Date of Recovery.	Name of Works.	Name of Owner.	Name of Injured.	Occupation of Injured.
100	Ap'l 24	May 8	Smelter........	Canadian Copper Company......	P. Eugenio......	Laborer.......
101	" 26	June 4	do	do do	J. Boweis........	Laborer.......
102	" 29	July 7	Crushing plant.	do do	G. Giovanni......	Laborer.......
103	" 30	May 10	Stockyard......	do do	S. Signoretti.....	Laborer.......
104	May 3	" 12	Smelter........	do do	A. Pic	Laborer.......
105	" 3	" 26	do	do do	V. Deloni........	Laborer.......
106	" 3	" 12	do	do do	J. Ikaraloka.....	Laborer.......
107	" 4	June 2	do	do do	M. Domenico.....	Laborer.......
108	" 4	May 22	do	do do	V. Pietro........	Laborer.......
109	" 6	" 14	do	do do	H. Cuezina.......	Laborer.......
110	" 6	" 19	do	do do	G. Taylor........	Laborer.......
111	" 10	" 17	do	do do	M. Paprenick....	Laborer.......
112	" 13	June 13	do	do do	M. Steajka.......	Laborer.......
113	" 15	" 2	do	do do	H. Traverse.....	Brakeman.....
114	" 15	" 16	do	do do	J. Quansincinojak	Laborer.......
115	" 16	May 23	do	do do	F. Klemp........	Tapper........
116	" 17	June 26	do	do do	J. Hudrga.......	Laborer.......
117	" 20	" 2	do	do do	A. Signoretta....	Laborer.......
118	" 21	" 3	do	do do	L. Angelo.......	Laborer.......
119	" 24	" 1	do	do do	Z. Luigi.........	Laborer .....
120	" 26	" 26	do	do do	O. Trottier	Carpenter ...
121	" 26	" 4	do	do do	M. Baby	Tuyere p'nch'r
122	" 26	Dec. 2	Crushing plant	do do	H. Silvestri	Laborer ......
123	" 29	June 23	Smelter........	do do	D. Tonuto	Laborer ......
124	June 2	" 10	do	do do	J. Dmytre	Carter ......
125	" 6	Perm'ly Disabled	do	do do	W. Polinski......	Brakeman ...
126	" 9	Aug. 11	do	do do	P. Cozoriz	Laborer ......
127	" 10	June 18	do	do do	O. Rauta	Fitter ....
128	" 12	" 23	do	do do	A. Morelli	Laborer ......
129	" 13	" 23	do	do do	M. Angelo	Laborer ......
130	" 16	" 30	do	do do	S. Domenick	Laborer ......
131	" 16	" 30	do	do do	J. Gault	Carpenter ...
132	" 18	....	Crushing plant	do do	W. Janick	Laborer ......
133	" 21	July 7	Smelter........	do do	D. Finn	Tapper ......
134	" 21	Aug, 18	do	do do	J. Thomas	Fitter ....
135	" 25	....	do	do do	G. Fairbairn	Engineer ....
136	" 25	July 14	do	do do	D. Tierney	Fitter ....
137	" 26	Aug. 6	do	do do	A. Bossack	Foreman ....
138	" 28	July 15	do	do do	M. Striko	Laborer ......
139	July 2	" 17	do	do do	M. Oskrowska ..	Tuyere p'nch'r
140	" 4	" 12	do	do do	B. Luigi	Laborer ......
141	" 4	" 15	do	do do	F. Minta	Laborer ......
142	" 5	" 28	do	do do	J. Martin	Brakeman ...
143	" 8	" 20	do	do do	T. Gletchineto...	Laborer ......
144	" 19	" 29	do	do do	L. Zenelea	Mechanic ....
145	" 23	Aug. 5	do	do do	S. Babonen	Laborer ......
146	" 24	" 6	do	do do	J. Francesco	Helper ......
147	" 25	" 4	do	do do	J. Garalaki	Laborer ......
148	" 26	" 12	do	do do	L. Patrini	Laborer ......
149	" 28	" 20	do	do do	C. Giovanni	Laborer ......
150	" 31	" 11	do	do do	S. Builing	Carpenter ...
151	" 31	Nov. 30	do	do do	Z. Makki	Driller ......
152	Aug. 6	Aug. 18	do	do do	E. Travers	Fitter ....

Metallurgical Works, 1913.—Continued.

Nationality of Injured.	Age.	Married or single.	Number Injured.	Nature and Cause of Accident.
Italian	26	S	1	Hand cut by piece of converter slag.
English-speaking	17	S	1	Finger cut on band-saw.
Italian	30	S	1	Arm crushed between spider of trommel and beam.
Italian	25	S	1	Pricked finger with iron strap on handle of coke fork.
Pole	31	S	1	Neck burned by hot calcines.
Italian	29	S	1	Fingers jammed between cogs of matte pot.
Finn	26	M	1	Stepped on nail.
Italian	19	S	1	Fell about 10 feet into bin.
Italian	27	S	1	Fingers jammed between pieces of ore.
Pole	22	S	1	Head cut by piece of ore falling from car.
English-speaking	28	S	1	Foot bruised by iron plate.
Pole	31	S	1	Face burned by explosion of contents of ladle.
Pole	32	S	1	Eye burned by not metal.
English-speaking	22	S	1	Foot bruised when locomotive left rail.
Pole	36	S	1	Finger crushed between two pieces of rock.
German	46	M	1	Nose broken by being struck with hammer.
Pole	28	M	1	Foot crushed by moving platform.
Italian	27	S	1	Foot crushed while moving machinery from car.
Italian	25	S	1	Toes bruised by car running over foot.
Italian	31	S	1	Arm bruised by conveyor belt.
English-speaking	41	M	1	Hand cut by rip saw.
Pole	21	S	1	Wrenched shoulder while chipping stock of converter.
Italian	18	S	1	Fell from ladder and broke leg.
Italian	27	S	1	Foot burned by hot slag.
Pole	28	M	1	Piece of roofing struck him on head.
Pole	22	S	1	Fell off locomotive and both legs amputated.
Pole	40	S	1	Ankle bruised between two cars.
Finn	32	M	1	Flue dust blown in eyes.
Italian	21	S		Fell off scaffold and injured side.
Italian	26	S	1	Struck by door of coal car.
Italian	24	S	1	Piece of matte fell on foot.
English-speaking	28	M	1	Fell 12 feet and injured back.
Pole	45	M	1	Arm broken by being caught in coupling of shaft.
Finn	24	S	1	Finger injured by being struck with hammer.
English-speaking	24	S	1	Finger amputated between cable and sheave.
English-speaking	60	S	1	Fell into round-house pit and bruised knee.
English-speaking	39	M	1	Hand injured while cutting rivets.
English-speaking	37	M	1	Foot crushed under spout.
Pole	33	S	1	Foot burned by metal.
Pole	27	S	1	Burnt by splash of slag while punching tuyere.
Italian	24	S	1	Slipped from platform and sprained ankle.
English-speaking	21	S	1	Hand injured while cutting rivets.
English-speaking	24	S	1	Slipped on stone and sprained ankle.
Pole	25	S	1	Hand cut by piece of slag.
Italian	27	S	1	Slipped and injured side.
Finn	39	S	1	Cut head against steam shovel frame.
Italian	37	M	1	Struck on neck by piece of slag.
Pole	29	S	1	Arm burned by hot calcines.
Italian	32	S	1	Hand bruised by fall.
Italian	34	M	1	Finger pinched by car.
Swede	26	S	1	Foot bruised by piece of concrete.
Finn	30	S	1	Hand bruised by hammer.
English-speaking	21	S	1	Fell 8 feet and bruised foot.

Table of Non-Fatal Accidents at

No.	Date of Accident.	Date of Recovery.	Name of Works.	Name of Owner.	Name of Injured.	Occupation of Injured.
153	Aug. 9	Sept. 1	Smelter	Canadian Copper Company	T. Frederico	Cleaner
154	'' 9	Aug. 18	do	do do	J. Brindley	Engineer
155	'' 12	'' 26	do	do do	C. Pilate	Laborer
156	'' 14	'' 27	do	do do	B. Giovanni	Laborer
157	'' 15	'' 22	do	do do	P. Albino	Cleaner
158	'' 16	'' 30	do	do do	G. Otrotoni	Laborer
159	'' 18	'' 29	do	do do	J. Kcaruz	Laborer
160	'' 20	Sept 6	do	do do	L. Domenic	Laborer
161	'' 23	'' 3	do	do do	L. Nozzoreno	Helper
162	'' 24	Nov. 3	do	do do	E. Gregorcheff	Laborer
163	'' 25	Sept. 4	do	do do	G. Bruce	Teamster
164	'' 27	'' 5	do	do do	D. Lenio	Laborer
165	Sept. 1	'' 13	do	do do	N. Soposki	Feeder
166	'' 4	Nov. 18	do	do do	H. Bethel	Carpenter
167	'' 6	Sept. 15	do	do do	F. Scarneki	Laborer
168	'' 6	'' 22	do	do do	D. Lampi	Laborer
169	'' 8	Jan. 8'14	do	do do	T. Guiseppi	Cleaner
170	'' 10	....	do	do do	G. McKenzie	Helper
171	'' 15	Oct. 13	do	do do	H. Meyers	Driver
172	'' 18	'' 4	do	do do	J. Newell	Helper
173	'' 22	'' 10	do	do do	N. Kryzowsky	Laborer
174	'' 25	'' 7	do	do do	S. Gresanowski	Laborer
175	'' 30	....	do	do do	J. Blackwell	Fitter
176	Oct. 8	Dec. 15	do	do do	R. Strutt	Electrician
177	'' 17	'' 10	do	do do	J. Luigi	Laborer
178	'' 21	....	do	do do	T. Regusz	Laborer
179	'' 22	Nov. 18	do	do do	G. Boyuck	Laborer
180	Nov. 25	Dec. 12	do	do do	V. Engera	Laborer
181	Dec. 19	Feb. 16	do		R. Hryrto	Tuyere p'nch'r
182	Mar. 7	May 1	Ore piles	Canada Iron Corporation	O. Somers	Laborer
183	'' 27	Ap'l 10	Blast furnace	do do	R. Tannahill	Blower
184	June 14	....	do	do do	R. Robbins	Machine runner
185	Feb. 1	Feb. 10	Arsenic plant	Coniagas Reduction Co., Ltd.	P. Jones	Laborer
186	Mar. 6	Mar. 15	Yard	do do	J. Vascla	Laborer
187	'' 8	'' 19	Furnace building	do do	D. Marchi	Cupeller
188	May 27	June 16	Shops	do do	H. Putman	Carpenter
189	June 6	'' 16	Furnace building	do do	E. Bellio	Laborer
190	July 19	....	Blast furnace	do do	J. Logue	Laborer
191	Aug. 18	Aug. 25	Power plant	do do	G. Storms	Millwright
192	Aug. 30	Sept. 15	Milling plant	Deloro Mining and Reduction Co., Ltd.	A. Kotch	Laborer
193	Feb. 2	Feb. 26	Smelter	Mond Nickel Co.	V. Formunch	Laborer
194	'' 17	Mar. 29	do	do do	T. Hydook	Laborer
195	Mar. 14	Ap'l 14	Roast yard	do do	E. Gratto	Laborer
196	Ap'l 10	'' 18	do	do do	O. Dundas	Laborer
197	June 27	Aug. 21	Smelter	do do	E. Piovessan	Helper
198	Ap'l 17	....	Blast furnace	North American Smelting Co.	E. Crellian	Laborer
199	July 8	....	do		F. Waite	Laborer
200	Jan. 8	Jan. 18	Blast furnace	Steel Company of Canada	C. Cesare	Laborer
201	Feb. 26	Ap'l 28	do		B. Guisseppi	Laborer

Metallurgical Works, 1913,—Concluded.

Nationality of Injured	Age.	Married or single.	Number injured.	Nature and Cause of Accident.
Italian..............	56	M	1	Face, shoulders and back burned by splash of matte.
English-speaking....	38	M	1	Ear cut and blood poisoning resulted.
Italian..............	33	S	1	Pinch bar slipped and jammed finger.
Italian..............	30	S	1	Blocking slipped, bruising toes.
Italian..............	28	S	1	Nail ran into foot.
Italian..............	39	S	1	Casting fell against leg.
Pole................	31	S	1	Foot bruised by piece of slag falling on it.
Italian..............	26	S	1	Foot bruised by piece of matte falling on it.
Italian..............	29	M	1	Piece of steel injured eye.
Pole................	31	S	1	Slag pot ran over foot.
English-speaking....	22	S	1	Pipe fell on ankle, bruising same.
Italian.............	18	S	1	Iron plate fell on foot.
Pole................	31	S	1	Head struck with furnace door weights.
English-speaking....	38	M	1	Fingers injured by splinter.
Italian..............	24	S	1	Fell and injured eye.
Finn...............	22	S	1	Hand burned by piece of hot coke.
Italian..............	27	S	1	Foot and hand jammed between crane and building.
English-speaking....	24	S	1	Clothing caught in shafting of emery wheel.
English-speaking....	22	S	1	Struck knee against truck.
English-speaking....	31	M	1	Finger torn by piece of screen.
Pole................	22	S	1	Fell and struck head.
Pole................	28	S	1	Rail slipped and fell on foot.
English-speaking....	21	S	1	Piece of pipe fell and bruised foot.
English-speaking....	19	S	1	Foot caught in conveyor and bruised.
Italian.............	23	S	1	Clothing caught in ash pan and arm broken.
Pole................	32	M	1	Piece of matte fell and bruised toe.
Pole................	27	S	1	Finger hit with hammer.
Pole................	23	S	1	Hammer slipped and struck leg.
Pole................	40	S	1	Slipped and cut leg.
English-speaking....	27	M	1	Jaw fractured and ear torn off while blasting in ore pile.
English-speaking....	38	M	1	Burned by metal.
English-speaking....	52	M	1	Fell from platform and injured hip.
English-speaking....	34	S	1	Door fell on foot injuring toe.
Roumanian.........	32	M	1	Wrist cut by piece of slag.
Italian.............	19	S	1	Struck by pot handle while dumping pot.
English-speaking....	28	M	1	Finger amputated by buzz planer.
Italian.............	18	S	1	Leg burned by hot slag.
English-speaking....	34	M	1	Fell into No. 3 ore bin, breaking leg in 3 places.
English-speaking....	30	M	1	Back injured while moving machinery
Pole................	....	......	1	Chest crushed by platform elevator descending.
Austrian...........	45	......	1	Slipped while dumping barrow and fractured 3 ribs.
Austrian............	31	......	1	Struck by piece of frozen ground and leg broken.
Italian.............	30	M	1	Fell from aerial tramway and broke small bone of leg.
Austrian...........	45	M	1	Slipped and fractured rib.
Italian.............	20	S	1	Fell 16 feet on slag track and broke arm.
English-speaking....	....	S	.....	Foot burned by slag.
English-speaking....	25	S	1	Hip injured by truck of pig lead falling.
Italian..............	24	S	1	Hand burned by slag.
Italian..............	28	M	1	Struck by shovel and eye lacerated.

Accidents at Quarries.

Under this heading are classified the accidents that occur in all kinds of stone quarries, gravel pits, and excavations at brick yards and cement works. During the year 1913, seven fatal accidents resulting in the death of eight men, and eleven non-fatal accidents resulting in injuries to twelve men, were reported to this office from such works.

At the Dill quartz quarry, operated by the Canadian Copper Company, a trammer was killed by being struck by a falling stone from the bank. The stone that fell had been embedded in the subsoil and had been loosened by heavy rains on the night previous to the accident.

A laborer in the gravel pit of the York Sand and Gravel Company at East Toronto jumped on the platform in front of the revolving crane and was instantly killed.

A laborer at the Vinemount quarry of the Wentworth Quarry Company was killed when the shovel tipped over while being moved. The engineer was absent at the time, and the craneman attempted to move the shovel.

A laborer was killed in the gravel pit of the Clifton Sand and Gravel Company, near Stamford, by being picked up in the clam shell. The accident was due to the fact that there was not any signal-man on duty at the edge of the pit to see that no person came near the clam. From his position on the derrick, the engineer could not see the clam when loading.

A contractor working in the clay pit of the A. H. Wagstaff's brick works, Greenwood Ave., Toronto, was killed by a fall of clay, on April 4th. This accident was due to the men taking a chance and not waiting till the bank cleaned itself.

Two men were killed at the Intercities Quarry, Port Arthur, by a premature explosion while loading a hole. The explosive used was gelignite (undated), and the explosion was probably the result of using unnecessary force while loading the hole with chilled powder.

A laborer was killed by a fall of clay in the clay pit of Ollman Bros.' brick works at Hamilton. The man was a Russian who understood very little English, and it is probable that the accident was due to his misunderstanding the foreman's orders.

The occupation of the men killed at quarries and their nationalities are shown in the following table:—

Occupation.	English Speaking.	Italian.	Roumanian.	Finn.	Russian.	Total.
Trammer	....	1	....	....	....	1
Laborer	2	....	1	....	1	4
Powderman	....	....	....	1	....	1
" Helper	....	....	....	1	....	1
Contractor	1	....	....	....	....	1
Total	3	1	1	2	1	8

The ages of the men killed at the quarries were as follows:—

20–25	26–30	36–40	41–45	46–50	51–55	56–60	Total.
3	1	1	2	0	0	1	8

The following shows the causes of the fatalities at the quarries.

	1912.	1913.
Struck by bucket of dredge	1	0
Struck by material from bank	0	3
Premature explosion	0	2
Picked up in clam shell	0	1
Crushed by machinery	0	2
Total	1	8

Table of Fatal Accidents

Number.	Date, 1913.	Name of Works.	Name of Owner.	Name of Deceased.	Occupation of Deceased.
1	Jan. 17	Dill Quartz........	Canadian Copper Co...	B. Giovanni....	Trammer......
2	Mar. 22	Sand pit..........	Clifton Sand and Gravel Co.	J. Papin.......	Laborer........
3	April 7	Quarry............	Intercities Quarry Co..	E. Pelto.......	Powderman....
	" 7	do	do do	J. Sessila......	Helper.........
4	May 6	Brick-yard.........	Ollman Bros.	Louis Tures...	Laborer.......
5	April 4	do	A. H. Wagstaff........	Geo. Jones	Contractor.....
6	Feb. 21	Quarry............	Wentworth Quarry Co.	Pat. McGrath..	Laborer........
7	Feb. 11	Gravel pit.........	York Sand and Gravel Co.	W. Forsyth....	Laborer........

Table of Non=Fatal Acci=

Number.	Date of Accident.	Date of Recovery.	Name of Works.	Name of Owner.	Name of Injured.	Occupation of Injured.
1	July 11	July 30	Clay pit....	Breslau Brick Co.	Castturat Mi..	Laborer........
2	Nov. 29	....	Quarry.....	Canada Cement Co. ...	Ben Weese.....	Powderman....
	" 29	....	do	do do ...	T. Nikola......	Drill Helper...
3	Jan. 28	Mar 4	Dill quartz.	Canadian Copper Co...	D. Delacco.....	Trammer......
4	Feb. 4	Mar. 24	do .	do do ..	Z. Vitoria......	Trammer......
5	Mar. 16	April 5	do .	do do ..	P. Cavassino...	Trammer......
6	July 29	Aug. 11	do .	do do ..	T. Arturo......	Trammer......
7	Sept. 13	Sept. 30	Quarry.....	Canada Crushed Stone Corporation	Jos. Oates.....	Craneman......
8	Nov. 18	Jan. 3	do ...	Hagersville Contracting Co.	A. Pignatello..	Driver.........
9	May 16	....	do	Ontario Rock Co.	D. Naibeff.....	Trammer......
10	Dec. 6	....	do	do do	O. Sanders.....	Trammer.......
11	April 26	May 12	Clay pit....	Sun Brick Co.	F. Livcola......	Laborer........

at Quarries, 1913.

Nationality of Deceased.	Age.	Married or Single.	In Quarry.	Outside Quarry.	Nature and Cause of Accident.
Italian	22	S	1	......	Struck on head by falling stone from bank.
Roumanian	58	M	1	......	Picked up in clam-shell.
Finn	25	M	1	....	Premature explosion while loading holes.
Finn	30	S	1	....	
Russian	38	S	1	......	Crushed by falling clay.
English-speaking	43	M	1	......	Buried under fall of clay.
English-speaking	45	S	1	......	Crushed under steam shovel which tipped while moving.
English-speaking	22	S	.....	1	Crushed between revolving crane platforms.
Total	....	......	7	1	

dents at Quarries, 1913.

Nationality of Injured.	Age.	Married or Single.	Number Injured.	Nature and Cause of Accident.
Italian	21	S	1	Leg broken by fall of clay.
English-speaking	34	M	2	Numerous cuts and bruises, premature blast.
Hungarian	35	M	....	
Italian	35	S	1	Tripped and sprained ankle.
Italian	42	M	1	Knee bruised, struck by derrick boom.
Italian	28	S	1	Leg jammed between log and stump.
Italian	18	S	1	Finger crushed under roller, while moving hoist.
English-speaking	29	S	1	Finger cut off, while repairing crane.
Italian	17	S	1	Leg broken below knee, riding on loaded car.
Macedonian	24	M	1	Struck in eye by piece of rock while sledging
English-speaking	18	S	1	Hand cut by piece of flying rock.
Italian	21	S	1	Back injured by piece of wood, while blasting on surface.

MINES OF ONTARIO

By T. F. SUTHERLAND, CHIEF INSPECTOR OF MINES

I.—NORTHWESTERN ONTARIO

There was no improvement in mining conditions in northwestern Ontario during 1913 compared with the previous two years as regards the number of properties working.

The Northern Pyrites mine on Big Vermilion lake was worked continuously throughout the year, and some diamond-drilling was done on adjoining claims in an effort to locate a continuation of the ore body.

In the Lake of the Woods area the Canadian Homestake Company continued development work at the Scramble mine, Jaffray township, west of the town of Kenora.

One or two of the old producing mines in this district were examined during the year by engineers representing companies looking for mining investment.

In the Sturgeon Lake area the St. Anthony gold mine operated during the first part of the year, but, owing to financial difficulties, work was discontinued.

During the latter part of the year several claims were staked in the vicinity of Mine Centre on the Canadian Northern railway west of Port Arthur. Some fine specimens of free gold were obtained, but, owing to the lateness of the season, nothing beyond staking was attempted.

Near Schreiber, east of Port Arthur on the Canadian Pacific railway, there was considerable activity in locating claims during the summer on what was thought to be a new nickel range. Work was confined to the necessary assessment to hold the claims.

The following brick companies are operating during the summer months in the vicinity of Port Arthur and Fort William:

Superior Brick Company, Twin City Junction.
Alsip Brick and Tile Company, West Fort William.
Gowanlock Brick Company, West Fort William.
Sand, Lime Brick Company, Port Arthur.
Fort William Brick and Tile Company, West Fort William.

Northern Pyrites Mine

The Northern Pyrites Company of 25 Broad street, New York, operated their pyrite mine at Northpines throughout the year. Northpines is about eleven miles west of Graham on the Grand Trunk Pacific railway.

During the year new stopes were opened on the second and third levels. These levels were also driven towards the eastern boundary. Preparations were made for sinking the main shaft another 100 feet, where a new level will be opened up both east and west.

In the crusher building a picking belt was installed to facilitate the extraction of quartz from the ore.

The new Leischan aerial tram, two miles in length, connecting the mine and the Grand Trunk Pacific railway, was in operation throughout the year. Of ore, 44,245 long tons were shipped to Buffalo, Chicago and Cleveland.

Mr. R. K. Painter is consulting engineer of the company, and Mr. H. V. Smythe superintendent at the mine, employing 84 men.

Canadian Homestake Gold Mine

The Canadian Homestake Gold Mining Company, Limited, head office, Toronto; Treasurer's office, 397 Delaware Avenue, Buffalo, N.Y., are operating the Canadian Homestake mine, formerly known as the Scramble mine. The property comprises an area of 294 acres, lots 13 and 14, concession 6, township of Jaffray, district of Kenora, five miles east of the town of Kenora.

The ore body is a shear zone, between 25 and 30 feet wide on the surface, and is traceable across the property to adjoining locations.

A 3-compartment shaft has been sunk to a depth of 210 feet. A level has been begun at 200 feet, and a cross-cut is also being driven at the same level. From this level connections will be made with No. 2 shaft.

Electric power is used at the mine, this being transmitted from the powerhouse at Kenora under 13,000-volt pressure. The current is stepped down at the mine to 440 volts. The company have a contract with the town of Kenora for 1,200 horsepower for twenty years.

The buildings comprise shaft house, blacksmith shop, dry, assay office and camps. These are heated by both steam and electricity and are lighted by electricity.

The equipment consists of a 600-foot Ingersoll-Rand compound compressor belt driven by a 100-h.p. induction motor. There are in use two 3¼-inch Holman drills, 1 Little Giant-Rand and 6 Ingersoll-Rand hammer drills; a 25-h.p. electric hoist is used for sinking.

The assay office is equipped with motor, crusher, grinder and oil-burning furnaces.

Plans are being prepared for a mill having a daily capacity of 500 tons which will be erected as soon as sufficient tonnage is available to warrant its erection. The mill will be electrically driven.

Mr. Chas. Brent is manager.

West Beaver Silver Mine

The West Beaver silver mine. 140 T, O'Connor township, Port Arthur Mining Division, is being worked under option by the Trethewey Silver Cobalt Mines, Limited, of Cobalt.

Regarding work at this property, the company, under date February 10th, state as follows:

> Work done consisted of erection of buildings, reopening the adit, cutting out and timbering a shaft station on the adit level at the foot of the shaft, the collar of which is 78 feet above the adit level, and sinking the shaft 26 feet below the adit. The shaft is a timbered 2-compartment inclined shaft, with a horse-whim cable and bucket in one compartment and a ladderway in the other. The shaft follows the vein, which has a dip of about 80 degrees and an average width of three feet, consisting of quartz, calcite, fluorite, and very variable amounts of zincblende, galena, argentite, and native silver.
>
> Since the beginning of the current year the shaft has been sunk to 55-foot depth below the adit, which is in slate just under the diabase capping, and a level started at 50 feet. Our intention is to drift to the southwest on the vein at this horizon and to test it by raises at various points.

Elizabeth Gold Mine

The Elizabeth Gold Mines, Limited, are operating on T.M. 171, Fort Frances Mining Division. This property is situated at the north end of Rice lake, about seven miles from Atikokan, on the Canadian Northern railway.

It is the intention of the company to instal a modern plant.

Mr. R. R. Gamey is president of the company, and Mr. J. P. Williams superintendent at the mine.

Inter-Cities Quarries

The Inter-Cities Quarries Company, Limited, formerly known as Stewart and Hewitson, are operating a trap rock quarry at Port Arthur. Two pits have been opened up. At the last date of inspection, March 9, 1914, only the north pit was in operation. This was being worked along a 200-foot face and was nearly worked out. The south pit measured approximately 300 feet by 400 feet. From the latter pit the cars are being hauled to the foot of an incline by a Stephens-Adamson car pull, driven by a 7½-h.p. motor. Thence they are hoisted up the incline by a friction hoist, and dumped into an Allis-Chalmers Gates No. 7½ gyratory crusher, driven by a 100-h.p. motor, which crushes the material to about 4-inch size. The product is delivered by a 30-inch belt conveyor to a hopper. This hopper feeds into a trommel, the oversize going into either a No. 5 Gates gyratory crusher, driven by a 75-h.p. motor, or to a No. 3 Austin gyratory driven by a 30-h.p. motor. The product is loaded into railway cars or wagons as desired, and is used for macadam or concrete work.

Mr. W. M. Colquhoun is manager, and Mr. John Jones foreman. In the summer months 110 men are employed.

Gowanlock Brick Company

The city of Fort William is operating the properties of the Gowanlock Brick Company at the foot of Mount MacKay, obtaining gravel and boulders for road construction. It is expected that the city quarry proper will soon be put in operation. The work is under the supervision of assistant city engineer Mr. J. Owen. Eleven men are employed.

II.—SUDBURY and the NORTH SHORE

The year 1913 was a most prosperous one in the history of nickel mining in the Sudbury district. The amount of diamond drilling done was greater than in any previous year since the range opened up, reaching a total of 91,632 feet. The drilling was done systematically and blocked out large bodies of ore for the three companies operating in the field.

The Canadian Copper Company and the Mond Nickel Company are widening their field of operation by developing and prospecting new properties, and by enlarging their smelter plants. The former did extensive development work at the new and largest mine, No. 3, and also increased the capacity of their smelter. The Mond Nickel Company are opening up a large property in Levack township. Drilling was carried on at this property during the summer and fall months, and shafts will be sunk early in 1914. This will likely be the largest ore body owned by the company. Development work was also carried on at the Frood Extension in McKim township, and the Worthington in Drury township. The smelter at Coniston was completed in June and is now operated to its capacity.

The British America Nickel Company, successors to Holmes and Wilson, did considerable work at the smelter site and town site at Nickelton, four miles west of Sudbury, and at Murray mine. With the exception of the Murray mine, however, all operations were closed down for the winter.

Moose Mountain, Limited, operated throughout the year. No. 1 mill ran continuously, while No. 2 mill was in operation about three months. The company did not have power enough to run both plants, and consequently the operation of No. 2 mill had to be curtailed. They are installing a large turbine plant early in 1914. This will furnish sufficient power for all their operations.

The Canadian Exploration Company at Long lake operated continuously throughout the year. The cyanide department was enlarged.

In the West Shining Tree district considerable development work was carried on, and there will likely be one or two small stamp mills in operation before the end of 1914.

Two trap rock quarries were in operation during the year, the International Trap Rock Company at Bruce Mines, and the Huron Trap Rock Company on St. Joseph's Island.

In the Michipicoten district several new properties are being opened up and the Helen and Magpie mines are in operation. After rearranging the plant, the Helen was started early in the fall. The company also did extensive drilling at the Helen and opened up a large body of siderite.

Diamond drills were in operation at the Josephine, Goudreau, and Morrison properties. The Josephine iron mine, which has not been worked for several years, will in all probability be opened up in 1914. The Goudreau pyrite property, owned by the Algoma Steel Corporation, was leased to the Madoc Mining Company. The latter have put up camps and are going ahead with the development work preparatory to mining. The Morrison is a new pyrite property near the Goudreau, and is under option by the Algoma Steel Corporation, who are drilling and prospecting it at present. The power plant at Steep Hill falls, owned by the Lake Superior Power Company, was completed and now furnishes power for the Magpie mine. Some interest was again shown in the Wawa gold district. The Grace mine was pumped out for sampling purposes, and much prospecting and development work was done on some claims north of Wawa.

Accidents

During the year there were twenty fatal accidents in and around the mines in this area; one at the blast furnaces at Sault Ste. Marie, and five at the smelters, or a total of 26. Compared with 1912, there is an increase of seven fatalities. Although there were more men working in 1913, the additional force was not sufficient to justify the increased number of accidents.

Late in the year, Mr. A. A. MacKay, superintendent of Helen mine in Michipicoten, was appointed Assistant Inspector of Mines for the Sudbury, Michipicoten and Western district.

Canadian Copper Company

In 1913, as in 1912, nearly all the production of the Canadian Copper Company came from the Creighton, Crean Hill and No. 2 mines. During the latter part of the year, however, there was a small production from No. 3 mine. The larger part of the output came from Creighton mine. Extensive development work was carried on at No. 3 mine on the 200- and 300-foot levels. The company are changing their methods of mining at all their mines, and are doing away with the dry wall drifts. They are using instead a shrinkage system with all the drifts in the solid.

The chief outside improvements were a macadamized road between Copper Cliff and No. 3 mine, and the extensive building of permanent houses at the several properties. At Copper Cliff about 60 good houses were erected during the summer months. At Creighton mine 20 new cottages were erected, and at No. 3 mine houses enough to accommodate 100 families were built. In addition to this, the town at No. 3 mine was incorporated under the name of Frood Mine and has a population of about 1,200.

During the year Mr. John Lawson resigned as president and was succeeded by Mr. A. D. Miles. The officers of the company at present are: Mr. A. D. Miles, president; Mr. B. G. Slaughter, vice-president; Mr. J. L. Agnew, general superintendent; Mr. J. C. Nichols, superintendent of mines; Mr. W. Kent, smelter superintendent; Mr. E. T. Corkill, safety engineer.

The company averaged 2,600 employees in the year 1913.

The appointment of Mr. E. T. Corkill as safety engineer was a step in the right direction, and it is likely other large companies will follow this lead. In fact, the Algoma Steel Corporation at Sault Ste. Marie propose making a similar appointment early in 1914. Since Mr. Corkill's appointment the accidents of the smelter and mines have been reduced by over fifty per cent. and the fatal accidents to a much greater extent. It is to be hoped that all mines will at least appoint a safety committee, especially in view of the increased accidents in 1913.

The company has moved into its new offices near the smelter building; these are of the most modern and well-equipped type. The new hospital at Copper Cliff, a description of which will be found under another heading, will be ready for occupation early in 1914.

A pipe line will be laid from Meat Bird lake to Copper Cliff to supply the town of Copper Cliff with water.

Creighton Mine

The larger part of the output of the Canadian Copper Company came from Creighton mine. The main hoisting shaft was sunk and timbered from the fifth to the seventh level, a distance of 233 feet. An ore pocket was cut at the sixth level. A crusher will be placed at the sixth level and all the ore mined on this level will be crushed before going into the pocket. There will also be an ore pass from the fifth level to the sixth. The ore from the fifth level will be drawn through the pass to the sixth level, and will be put through the crusher before being dropped into the pocket. Apart from being a means of taking the ore from the fifth to the sixth level, the ore pass will be used as a storage pocket in case of any delays on surface. All the ore will be hoisted from the sixth level pocket. Placing crushers underground is a new departure in this district, and will no doubt largely increase the output of the mine. There will be no chance of ordinary surface delays hanging up the trammers for any length of time. It will also be much easier to load the skips with a sized product from the ore pocket than with a product that contains lumps. It is estimated that with the new underground equipment the mine can keep up an average daily ouput of 2,000 tons.

The east ore body on the sixth level has been fully developed and stoping begun. In the new system of mining drifts are driven in the solid ore, raises put up and stopes begun from the raises. A good substantial back is left over the drifts, and pillars are left at stated intervals. The shrinkage system will be used to mine the ore. It is estimated that not over ten per cent. of the ore will be left in the pillars. Stoping was carried on throughout the year on the fifth level and on the east end of the third and fourth levels, open pit.

On December 9th, Nos. 1, 2 and 3 pillars, holding up the north wall of the open pit, collapsed, carrying with them about forty feet of the brow for a horizontal distance of about 200 feet. It is estimated that 230,000 tons of ore and rock fell into the pit. Outside of breaking the dry wall drifts on the fifth level between No. 1 and 2 shafts, very little damage to the mine was done. The fall curtailed the output for about a month. A new hoist is being installed, and when the ore pocket is completed at the sixth level larger skips will replace the 2½-ton skips now in use. Two compartments of the shaft will be used to hoist ore, and one compartment for hoisting tools, timber and men. Safety man-skips will be put on early in 1914.

Crean Hill

Crean Hill mine, situated three miles northwest of Victoria Mines, was operated continuously during the year. The main shaft was sunk to the eighth level, a distance of 117 feet, and the winze was sunk from the eighth to the ninth level, a distance of 112 feet. A drift will be started immediately to a point under the shaft, and the shaft will be raised from the ninth to the eighth level. The ore body was opened up on the eighth level, and a large stope started. There is also work being done at the fifth and sixth levels. On the sixth level, some of the old stopes are being enlarged, while on the fifth level the filling in the old stopes is being worked over. From the eighth level down the new system of mining will be carried out.

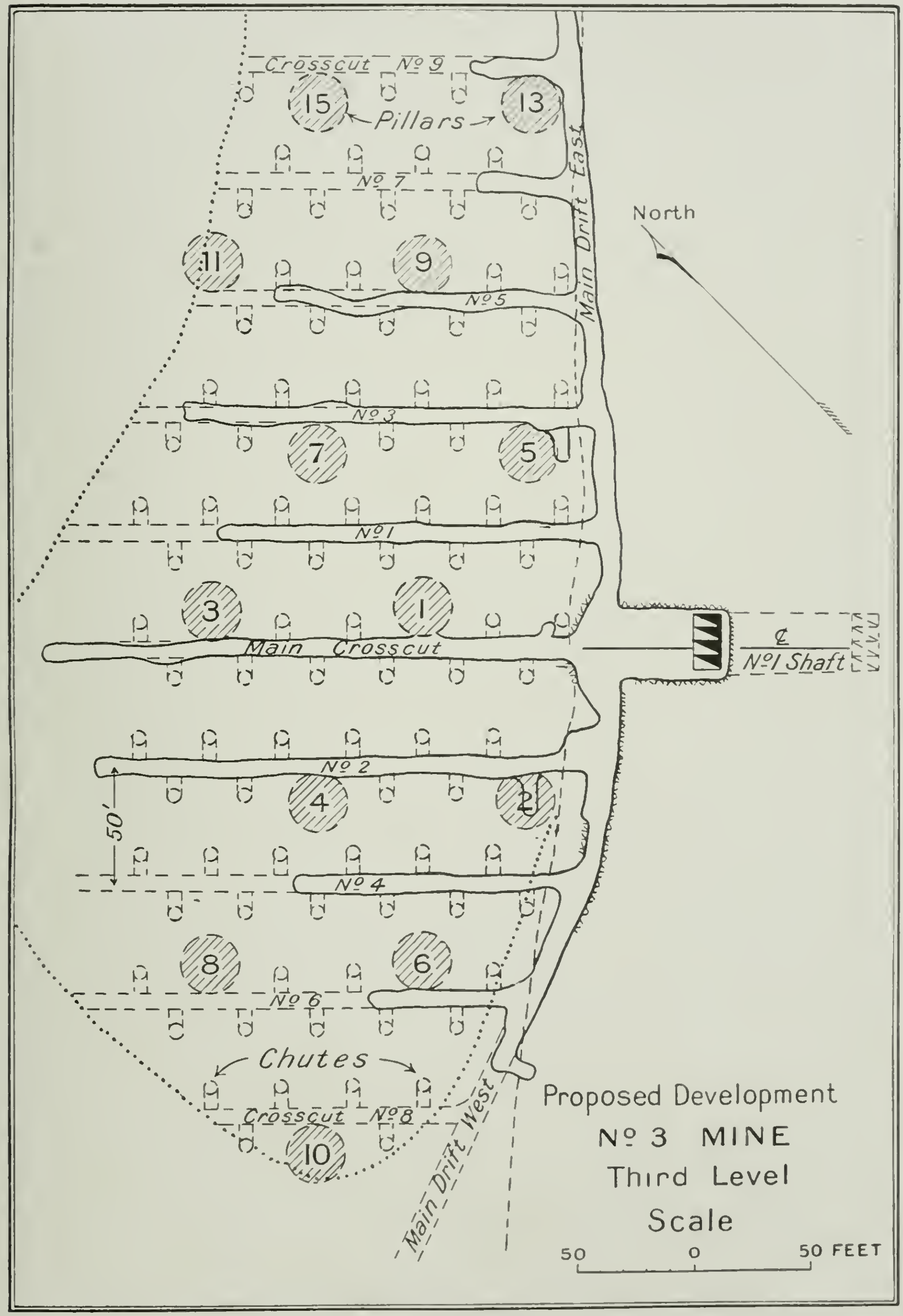
Mr. C. Collins is the local superintendent.

No. 2 Mine

The main shaft of No. 2 mine was sunk to the ninth level. This makes the total depth of the shaft 721 feet. Owing to the ore body dipping and getting so far away from the shaft, it was decided to sink a second shaft from the ninth level down. This shaft was started on the incline 175 feet north of No. 1 shaft at the ninth level, and was sunk to the tenth level, a distance of 130 feet. It was also raised to the eighth level. A pocket was cut at the ninth level.

The hoist is on the eighth level. The skips are hoisted above the ninth level, and the ore dumped into the pocket. The ore is trammed from this pocket to No. 1 shaft.

Mr. W. Hambly is the local superintendent.



No. 3 Mine, Sudbury

No. 3 Mine

Extensive development work was done at No. 3 mine during the year. No. 1 shaft, which is 400 feet deep, had no work done on it, but No. 2 shaft was sunk from the 200-foot to the 300-foot level, and a drift 625 feet long was driven to connect the two shafts at the third level. The new system of mining will be used at this mine as well as at the other mines owned by the company. The system at this particular mine consists of driving a long main drift, a short distance south of the ore body, and taking the general direction of the ore body on the south side. Cross-cuts 50 feet apart are driven north from the main drift at right angles to it. Raises are put up on the cross-cuts about 50 feet apart and are placed alternately on either side of the drift. These raises are breasted out and joined at a height of 15 feet above the floor level, thus merging into a large stope. Pillars 25 feet in diameter are left to support the back, and the ore will be taken out by the shrinkage system.

The development work on the third level is finished and the level is ready for stoping. A pipe line is being laid from Whitson lake, a distance of four miles, to supply water for the mine and the town of Frood Mine, which has a population of about 1,200. The town itself was built by the company within the past year.

A vertical compressor, with a capacity of 5,000 cubic feet per minute, is being installed in the new powerhouse.

Mr. T. McNamara is the local superintendent.

New Hospital of the Canadian Copper Company

Dill Quartz Quarry

About 300 tons of quartz per day were mined and shipped from the quartz quarry in Dill township. The quartz is mined by open-cut work.

During the summer a large storage bin was built beside the track, and an incline run from the top of the bin to the bottom of the cut. The quartz is loaded into small cars, hoisted up the incline and dumped into the bin. This new method should be much safer than the old one of hoisting the buckets by a derrick. The quartz is loaded into railroad cars at the bin and hauled to Copper Cliff, where it is crushed for use at the furnaces and converters.

Mr. H. Whitehead is local superintendent.

Hospital

The Canadian Copper Company have erected at Copper Cliff a large hospital, to replace the one destroyed by fire in 1912. The new building, which in design and equipment is not surpassed by any in Canada, was erected at a cost of $250,000. In form the building is T-shaped, with spacious sunrooms at either end. There are four floors with a total area of 28,000 square feet, exclusive of sub-basement.

Opening off the main corridor are the dispensary, doctors' office, several private wards and two large typhoid wards and a separate private exit for out-patients. The sterilizing room is also located here. To the right of the main entrance is the surgical wing, comprising a number of private wards and bathrooms. The second storey contains doctors' and nurses' apartments, private and semi-private wards.

In the basement are the X-ray and dark rooms, laundry and drying rooms, morgue and post-mortem rooms, and a room containing an electric light bath for the treatment of skin diseases.

Dr. McAuley is medical superintendent, with a staff of five physicians and five nurses.

Mond Nickel Company

The production of the Mond Nickel Company for the year 1913 came from the Garson, Mond and North Star mines, but mostly from the first named. Development and construction work was carried on at the North Star, Worthington, Frood Extension, Kirkwood and Levack properties. The company's new smelter at Coniston was completed in June, and is now operating at full capacity. Diamond drilling was carried on extensively at Levack, and a large body of high-grade ore was blocked out. Shafts will be begun on this property early in 1914. It is estimated that this is the largest body of ore owned by the Mond Nickel Company.

The officers of the company are:—Mr. C. V. Corliss, manager; Mr. O. Hall, mine superintendent; and Mr. J. E. Robertson, smelter superintendent. There are also local superintendents at each of the properties. They employed an average of about 1,200 men during the year.

Mond Mine

The main shaft of this mine is now at a depth of 2,027 feet vertically, by far the deepest shaft in the Province. The main operations during the year were confined to the tenth, twelfth, fourteenth and sixteenth levels, developing the eighteenth level and sinking the shaft. The ore encountered on the 1,600 and 1,800 foot levels is as good or better than on the upper levels. Apart from the east and west ore bodies, a new high-grade body was encountered north of the west ore body on the 1,400-foot level. This body has been stoped to a height of 100 feet, and shows high-grade ore in the back. The ore is hoisted on cages and treated in the usual way at the surface.

Mr. Mumford is the local superintendent, employing 165 men.

Garson Mine

The ore production from this mine during the year came from the first, second, third and fourth levels. The shaft was sunk 170 feet, making a total depth of 870 feet. On account of the ore body being irregular in size and shape, the plans of the workings of the several levels projected to the surface cover a large area and are difficult to describe. Some of the stopes are mined by filling and some by underhand stoping. In future, underhand stoping will be employed whenever the bodies are not too wide to allow of this method.

The cages were taken off during the year and replaced by automatic dumping skips with a capacity of four tons. The skips are equipped with a safety device, and are handled by a double-drum electric Nordberg hoist. This hoist is equipped with automatic devices to prevent overwinding, and to govern the speed of hoisting and lowering. The men are lowered and hoisted in these skips. On the upper levels the ore is trammed to the shaft in 1-ton and 1½-ton cars. Three of the 1-ton cars are dumped into the skips or two of the 1½-ton cars. An ore pocket was cut between the fourth and fifth levels. All the ore mined on the fourth level is dumped into this pocket. Also nearly all the ore from the second level is carrid through an ore pass to the fourth level and dumped into the pocket. The skips are loaded at the fifth level by means of a small loading pocket. This loading pocket, which holds a skip load, is filled from the main pocket. When a pocket is full the load is allowed to run into the skip. This prevents too much ore getting into the skip. The miners' dry house was enlarged and several other buildings built during the year. Mr. A. L. Sharp is local superintendent, employing 320 men.

Frood Extension Mine

Frood Extension Mine

The Frood Extension shaft is situated on the northeast quarter of lot 7 in the sixth concession of McKim township, a short distance from the No. 3 workings of the Canadian Copper Company.

Shaft No. 1 is vertical, with four compartments, size 21 x 7 feet, and has reached a depth of 900 feet.

The first level station has been cut at 400 feet, with a drift to the south 250 feet in length. From this point a raise has been driven connecting with No. 2 shaft. At the 750-foot or second level, a drift to the south has been driven 200 feet.

The shaft is timbered to a depth of 850 feet, the main bulkhead being constructed about 12 feet below the second level. The third level station will be cut at 900 feet, where the main ore body will be first developed. It is the intention of the management to sink this shaft to a depth of 1,100 feet before mining is begun.

Shaft No. 2 is vertical, size 5 by 9 feet, and 208 feet deep. From this point connection is made by a raise from the first level south drift. This raise is inclined at 45 degrees.

The company in March, 1914, began the installation of a new compressor and hoisting plant. It is expected that this plant will be in operation by June 1st, 1914.

The hoist is of Nordberg air-driven type, cylinders 23 by 23 inches by 48. It has two drums 10 feet in diameter, and is so constructed that a third drum may be installed. Its speed is 1,000 feet per minute, using a 1$\frac{3}{8}$-inch cable and 5-ton skip.

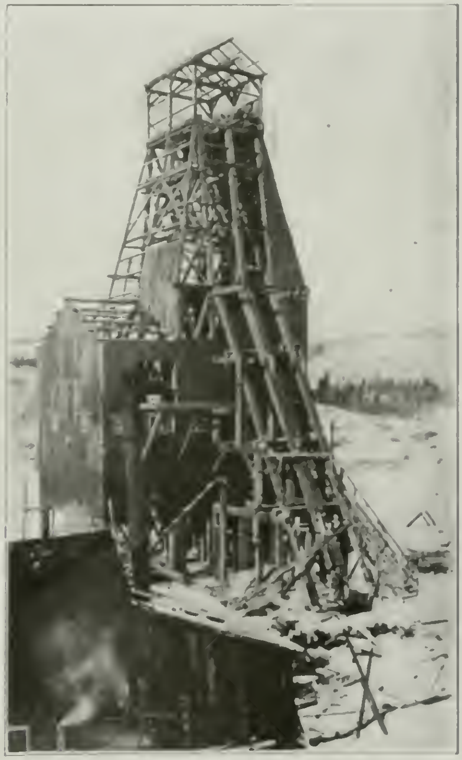
The Nordberg compressor has a capacity of 2,800 cubic feet per minute, and is driven by a Westinghouse synchronous motor direct attached.

There are two receivers, each 30 feet long by 10 feet in diameter, and from these the air passes into a re-heater before being delivered to the hoist. Any surplus air not required to operate the hoist will be used in the mine.

In addition to this air plant there is a Rand compressor of 2,000 cubic feet capacity, belt-driven from an Allis-Chalmers motor. The company have erected several comfortable houses for the miners, and a small village known as Frood Extension has been incorporated.

Plans for a rock house, dry house, magazine and thaw house are now ready, and these buildings will be erected during the summer of 1914.

Mr. J. H. Stovel is superintendent, employing 100 men.



Construction of Headframe at Worthington Mine

North Star Mine

The mine, which was reopened during 1912, was operated continuously during 1913. A shaft was timbered through the open pit about 170 feet, and then continued through the solid to a total depth of 300 feet. Stations were cut at 120 and 240 feet, and the levels developed. Several new buildings were erected, including a large power house, in which is installed a Canadian Rand Corliss valve compressor, of 1,700 cubic feet capacity, a double-drum hoist and electric transformers and equipment. All the machinery is operated by electricity.

The greater part of the output in the year was taken from the first and second levels. The shaft is being sunk to the third level. The ore is hoisted in cages in an incline shaft.

Mr. J. H. Smeltzer is the mine superintendent, employing about 145 men.

Worthington Mine

The old Worthington mine, situate about twenty-five miles west of Sudbury on the Sault branch, was reopened by the Mond Nickel Company during 1913. A 3-compartment shaft was sunk from the surface to the first level, a distance of 200 feet. This shaft connects with the old shaft and workings of the mine. There was also a small amount of developing work done on the first level and the 80-foot level.

The head frame and rock house were erected at the collar of No. 2 shaft, and are about completed. The rock house and bins are a departure from the type heretofore used in the district. For this reason the operation of the bins will be watched with great interest. If they work well it is likely more of the same kind will be built in future.

A large brick powerhouse was erected during the year, and an 1,800-foot compressor, a double-drum hoist and transformers were installed. Several new cottages of a good substantial type were put up nearer the mine.

Mr. R. M. Palmer is local superintendent, employing 110 men.

Kirkwood Mine

This mine, which is about two miles west of the Garson mine, was opened up by the company during the year. The old workings include a pit about 60 feet deep and 30 feet in diameter. This pit is used at the present time for hoisting the ore through, and work has been continued in it. The ore is hoisted in buckets and will be taken by a tramway to the Garson for shipping. A shaft is about to be begun in the bottom of the pit. A 6-inch pipe line supplies compressed air from the Garson.

Mr. Thoenen is local superintendent, employing 54 men.

Coniston Smelter

On Lot 3, in the third concession of the township of Neelon, the Mond Nickel Company have erected a new smelting plant. A large acreage has been purchased in this township, and a flourishing village has grown up near the plant. The old smelter at Victoria mines has been dismantled, and the offices removed to Coniston, where an ideal smelter site has been obtained. Situated about eight miles east of Sudbury, on the main lines of the Canadian Pacific railway and Canadian Northern railway, direct connection is afforded to all the company's mines in the district. Ore from the Garson mine is shipped via Canadian Northern, Victoria mine ore via Algoma Eastern and Canadian Northern, and the Canadian Pacific railway gives direct connection with the Frood Extension and Levack properties.

Work on the new plant began in 1911, and the furnaces were blown in on May 12th, 1913.

The plant consists of three modern Allis-Chalmers blast furnaces, size 50 x 240 inches, each having 32 4½-inch tuyeres, through which air is blown at 30-ounce pressure.

The roasted ore is brought in from the roast yards about three-quarters of a mile distant via Canadian Northern, and delivered to the bins in standard gauge ore cars. The furnace charge, which consists of roasted and green ore in equal parts, converter slag, limestone and coke, is delivered to the furnaces in cars of 500-pound capacity, hauled by an electric locomotive.

On the date of inspection, two furnaces were in blast, each smelting 400 tons of ore per 24 hours, which amount may be increased in the future. The furnace matter, containing about 20 per cent. copper and nickel, is tapped into a settler 20 feet in diameter. From the settler it is tapped into a 10-ton ladle, and conveyed by a Whiting foundry 50-ton crane to the converter. There are three Pierce-Smith standard basic converters, each having a capacity of 20 tons per day of Bessemer matte, containing 80 per cent. copper and nickel.

The converter slag is tapped into ladles and returned to the furnaces. The Bessemer matte is poured into moulds, and broken up for shipment in oak casks to the company's refining plant at Clydach, near Swansea, Wales.

The flue dust and a portion of the ore fines are sintered on a Dwight-Lloyd straight line sintering apparatus, and the sulphur reduced to one-half its original percentage. The product from this machine is returned to the blast furnace. The sintering plant is still in the experimental stage.

The main furnace building is 360 by 140 feet, the converters being in the same building, placed directly in front of the blast furnaces.

Air is furnished by two Nordberg blowers, having a total capacity of 17,000 cubic feet of air, and three Connelsville blowers with a capacity of 16,000 cubic feet; one large Connelsville blower is being installed.

Electric power from the Wahnipitae Power Company is used throughout the smelter.

The main furnace stack is 200 feet high and 16 feet inside diameter, and the sintering plant stack is 175 feet high, and eight feet in diameter. Both were built by the Alphonse Custodis Chimney Construction Company.

Mr. C. V. Corliss is manager, and Mr. J. E. Robertson smelter superintendent.

British America Nickel Company

The British America Nickel Company, successors to the Dominion Nickel Copper Company and Holmes and Wilson, confined their operations to development work at the Whistle, sinking the Murray shaft, and construction work at Nickelton—the townsite for the company's proposed smelter, four miles west of Sudbury. During the summer months several houses were built at Nickelton and a smelter site located, and a large staff of engineers worked all summer on the plans for the smelter, etc., and had the same almost completed. In the fall, all operations were suspended, with the exception of the shaft at the Murray. It is stated that the smelter construction was stopped on account of shortage of material, and also that there was no need of having the smelter completed until there was ore enough developed to supply the same, which will have a capacity of 1,000 tons per day.

The company had several diamond drills at work during the early part of the year on the Murray and Elsie properties. After the large deposit was located on the Murray, the company bought out the Gertrude, Elsie and Victor from the Lake Superior Corporation. They now own 21 properties, and it is estimated that they have a very large tonnage of ore blocked out. It is likely the construction of the smelter will be continued during 1914. Electric power for mines and smelter will be brought in from a large power plant.

The officers of the company are:—F. S. Pearson, president; J. Frater Taylor, vice-president; J. C. McAllister, managing director; J. A. Holmes, manager; E. E. Hibbert, superintendent of mines; R. W. Deacon, metallurgical engineer.

Murray Mine

A 3-compartment shaft was begun at the Murray Mine in 1913, and is now down 400 feet on an incline of 36 degrees. The first station has been cut and timbered. The shaft is so flat that a stairway was built in it for the men to walk up and down on. It is the intention of the company to sink the shaft to a total depth of 1,200 feet. The shaft is located east of the ore body and is in the solid rock throughout. It dips at about the same angle as the ore body.

Mr. E. E. Hibbert is superintendent, employing 45 men.

Long Lake Gold Mine

The Canadian Exploration Company operated their mine and mill at Long lake continuously during 1913. By the addition of a new tube mill and extensive changes in the cyanide department the capacity of the 20-stamp mill will be almost double in 1914. The present capacity is about 120 tons per day.

During the summer months all the ore is broken in the open pit and dropped down to the first and second levels through ore passes. On the first level the ore is trammed to the shaft and dumped into an ore pocket which holds about 30 tons. The skips are loaded from the ore pocket, and hoisted to a bin at the collar of the shaft. An aerial tram takes the ore from this pocket to the mill bins, a distance of about 300 feet. The buckets are loaded at the bins and dumped automatically at the mill. In the winter months the ore is mined underground by overhand stoping. At present stoping is being carried on at the first level. Part of the broken ore is dropped directly into the 100-ton pocket on the second level through an ore pass, and part of it is trammed to the shaft at the first level. The open pit is about 100 feet in diameter and 40 feet deep. The shaft is 225 feet deep vertically. All the development work is done on the first and main level. A new vertical direct-driven compressor of the marine type was installed during the year.

Surface Plant at Long Lake Gold Mine

Mr. R. W. Brigstocke is manager, employing 85 men.

Moose Mountain Iron Mine

The Moose Mountain mine, which is in the town of Sellwood, 33 miles north of Sudbury, on the Canadian Northern Ontario railway, operated continuously during 1913. No. 1 mill, which is used to concentrate the ore from Nos. 1, 5, and 6 ore bodies, ran steadily during the year. The ore from these three deposits is put through a No. 9 gyratory crusher and taken by a belt conveyor to a large bin in the mill. From here it passes through more gyratory crushers, which crush to a 1-inch ring, and is concentrated magnetically. The greater part of the rock is sold as trap rock. The total output of the three ore bodies in the year was 146,000 tons, while No. 1 mill turned out 104,000 tons of finished product.

General View of Moose Mountain Mine

No. 2 mill, which was only in its experimental stages, operated for the first three months in the year, but had to be closed down on account of a shortage of power. This mill takes care of all the dust and fines from No. 1 mill, and the output of the several ore bodies that cannot be concentrated in No. 1 mill. The ore is crushed very fine and concentrated magnetically. The concentrates are briquetted and fused. After the fusion takes place the briquettes are solid enough to stand very rough usage and contain about 63 per cent. iron. This process also removes some phosphorus and gives a Bessemer product.

No. 1 deposit furnishes nearly all the ore for No. 1 mill. The ore is broken in the open pit and dropped to the first level through large ore passes. It is hoisted from there in skips through the 3-compartment shaft. No. 5 deposit furnishes a small amount of ore to No. 1 mill. This deposit is about 1,000 feet south of No. 1. The ore is taken from No. 5 deposit to the crushers by gravity, and the empty skips are hauled back. The shaft was sunk 60 feet during the year.

Mr. F. A. Jordan is manager, employing 238 men.

Algoma Steel Corporation

The Algoma Steel Corporation operated the Helen and Magpie mines in Michipicoten and the blast furnaces at Sault Ste. Marie, and did extensive diamond drilling at the Helen, Josephine and Morrison properties. The Josephine is one of the old properties which contain hematite. The Morrison is a pyrite property near the Goudreau, and is being developed and tested. The Goudreau was leased to the Madoc Mining Company, who are drilling on it at present, and intend to operate in the near future. Construction work was carried on at the Helen and Magpie mines.

Mr. J. Frater Taylor is president; Mr. W. E. Franz, vice-president; Mr. S. Hale, manager; Mr. A. Hasselbring, superintendent of mines.

Roasting Plant at Magpie Mine in Course of Construction

Magpie Iron Mine

At the Algoma Steel Corporation's Magpie mine in the Michipicoten district, experiments in preparing siderite ore for the market have been under way since January 1st, 1913.

The siderite, as it comes from the mine, carries from 33 to 37 per cent. iron, and an objectionable percentage of sulphur. Consequently the treatment in preparing the ore for market must include both calcination and de-sulphurization.

The roasting plant erected for the first attack on this problem consisted of one 125-foot rotary kiln, discharging into two 60-foot rotary kilns. The 60-foot kilns were fired with producer gas, and the 125-foot kiln with the waste gases from the shorter kilns. Powdered coal was also tried instead of gas for firing the kilns. Later, an attempt was successfully made by Mr. Hasselbring to effect both calcination and de-sulphurization in the 125-foot kiln alone, using powdered coal as fuel. The result, so far, has been satisfactory.

This being the pioneer attempt to make the siderite ore of New Ontario marketable, there are, naturally, many difficulties to contend with. The Algoma Steel Corporation have, however, considered it advisable to erect new roasting units, laid out in such a way as the experience of the past few months suggests, in the hope that the larger tonnage secured from a plant of several units may sufficiently reduce the cost of producing a marketable ore.

The new units will consist of one 125-foot kiln each, fired by powdered coal.

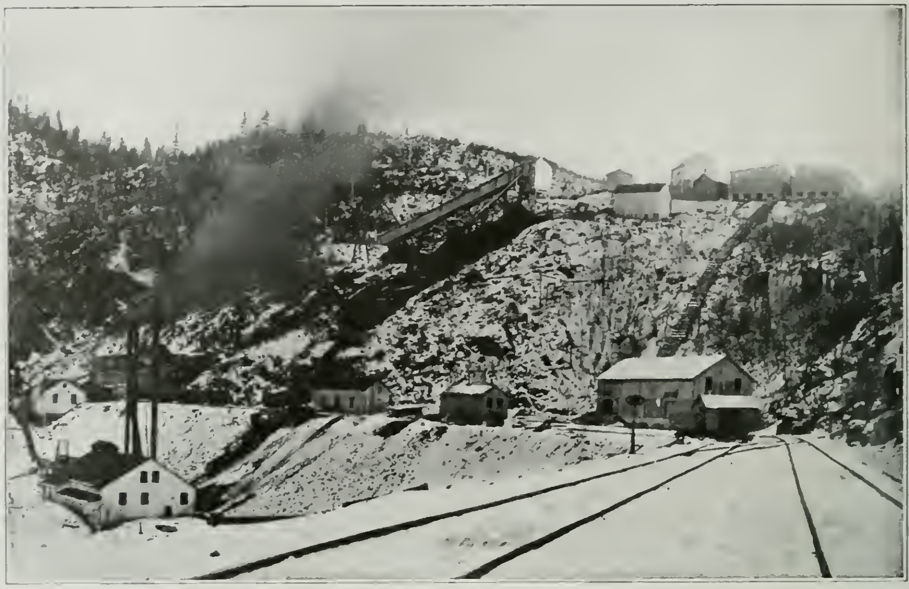
Helen Iron Mine

The production of hematite from the Helen iron mine in 1913 was not as great as in 1912. This was due mainly to the fact that the old shaft was moving towards the open pit, between the second level and the surface. For this reason No. 2 shaft had to be extended on an incline of 61 degrees from the fourth level to a point on the surface 200 feet south of the collar of the old shaft and 150 feet higher. The total distance driven was 481 feet. It may be interesting to know that the last 235 feet of the shaft, which was 6 by 14 feet inside timbers, was raised and timbered with the regular 10 by 10-inch sets placed at 5-foot centres in 22½ days of two ten-hour shifts.

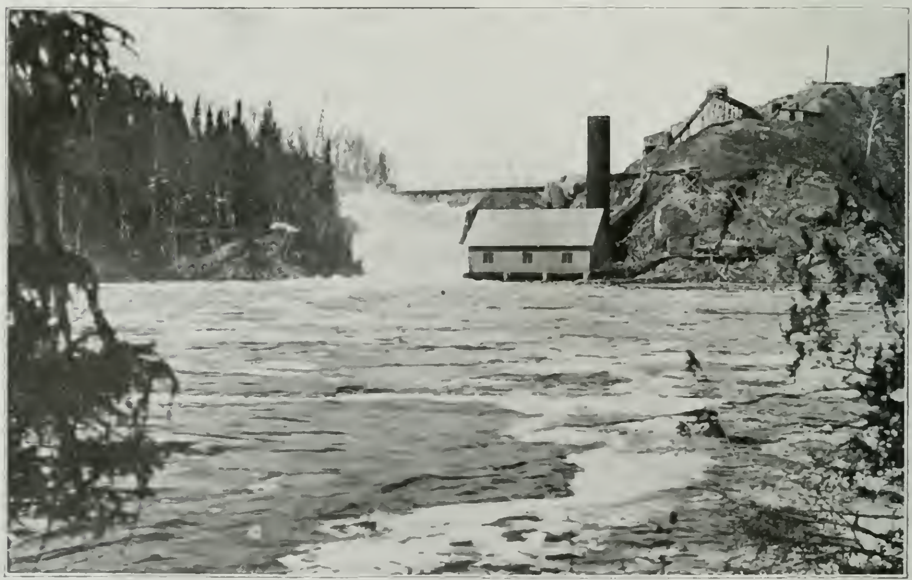
View of Tubes, Magpie Roasting Plant

The crusher was moved from the old to the new location at the top of the hill. The hoist was moved 300 feet farther south and 75 feet higher. A belt conveyor, 240 feet long, was installed to carry the crushed ore from the crusher to the ore bin on the side of the hill. The ore is carried by gravity from the belt conveyor to the railroad cars.

Ore was mined on the sixth and seventh levels. On the former the pillars were robbed, but the greater part of the ore was won from the fall above the sixth level under the open pit. This ore comes principally from the pillars that collapsed on the third, fourth and fifth levels in 1911. All the ore from these pillars cannot be saved, because it is badly mixed with pyrite.



General View of New Plant at Helen Mine



Steep Hill Falls Power House, Michipicoten

On the seventh level the ore is mined by the caving system. Three sub-levels are being worked between the sixth and seventh levels. These sub-levels are 15 feet apart, and are carried in a series of steps from the sixth to the seventh level. All the ore is trammed into raises by 1-ton cars, and goes to the eighth level. It is taken from the raises on the eighth level to the shaft in 2-ton cars.

A large deposit of low-grade pyrite, which lies under Boyer lake, will be opened up in the near future. This pyrite occurs in the form of sand. The impurities are very small particles of iron ore intimately disseminated throughout. A concentrating plant will be installed to handle this pyrite.

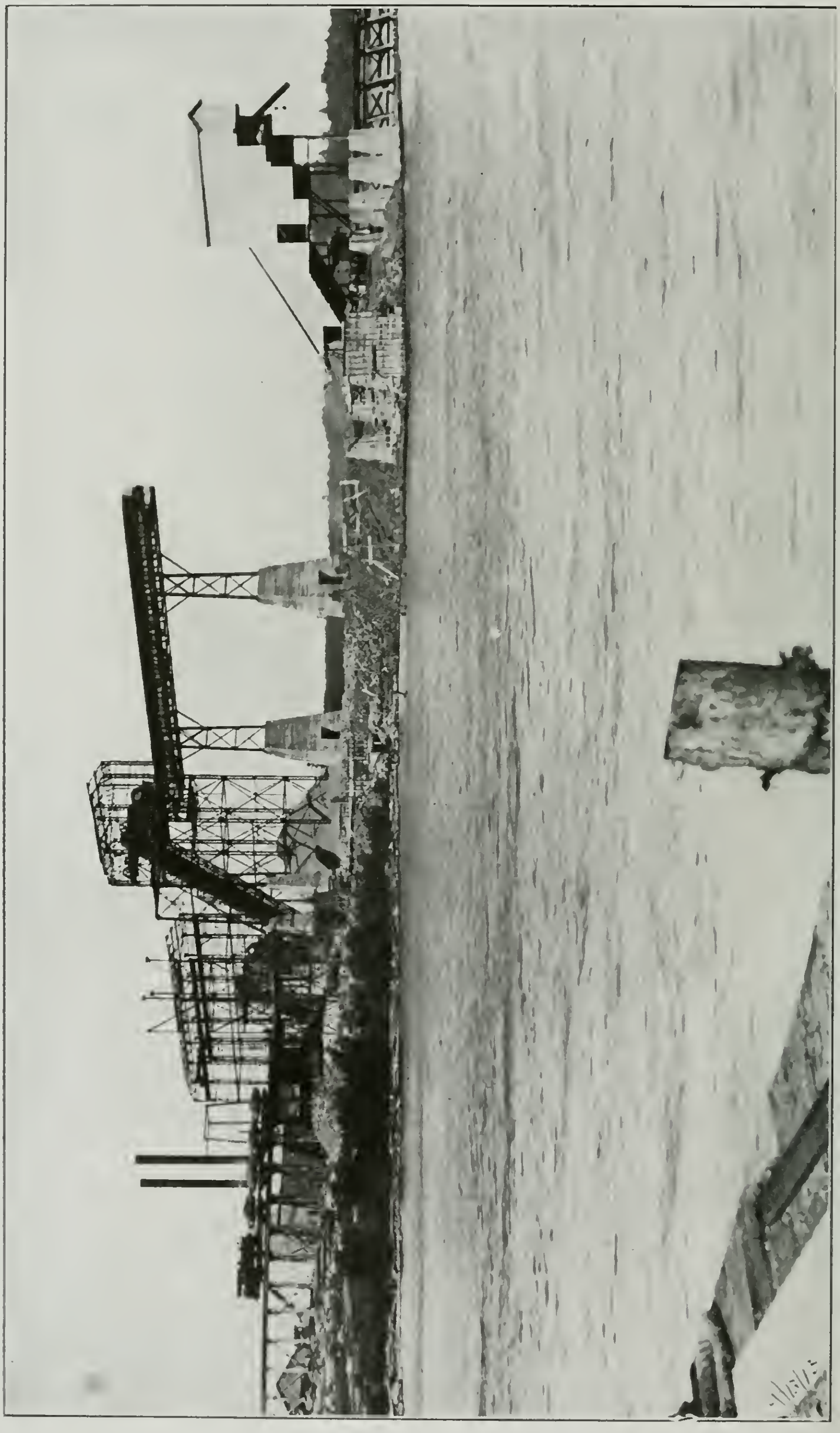
A. A. MacKay, superintendent, was succeeded by G. R. MacLaren in September. An average force of 80 men was employed.

International Trap Rock Company

The trap rock quarry at Bruce Mines was opened up and a large plant installed in 1913.

The rock is taken from the quarry and hauled in 5-ton cars to a 5 by 7-foot jaw crusher, which is said to be the largest crusher in Canada. The rock is discharged from the jaw crusher into No. 9 gyratory crushers, and is fed from there to a series of bucket conveyors. From these it goes to a series of revolving trommels, in which it is sized. The several sizes are taken on belt conveyors to the stock yard. Two concrete tunnels run under the stock yard, and the rock is fed on to a belt conveyor which runs in the tunnels; this takes the ore directly to the boats.

It is estimated that the plant can handle from 400 to 600 tons of material per hour. Mr. Martin is superintendent.



Crushing and Loading Plant of International Trap Rock Company

III.—TIMISKAMING

Cobalt and Vicinity

The production of silver from the Cobalt district was approximately half a million ounces less in 1913 than in 1912, being 29,682,015 ounces, as compared with 30,243,859 ounces during the previous year. This represents about 14 per cent. of the world's total production of silver.

Four new dividend payers appeared during 1913: Seneca-Superior, Casey Cobalt, Cobalt Lake, and Caribou Cobalt, formerly the Drummond mine. The most important features of the year were the satisfactory results obtained during development by the Casey Cobalt mine in Casey township, also by the Seneca-Superior on Cart lake, Coleman township, and the remarkable high-grade veins exposed on the Kerr Lake Mining Company's property by the dewatering of Kerr lake.

Owing to the gradual depletion of the high-grade veins in the Cobalt district, the mining companies are increasing the amount of low-grade ore being treated, resulting in the employment of more men and demand for more power. The Northern Ontario Light and Power Company are developing an additional 4,000 horse-power at Fountain falls on the Montreal river, 10 1-3 miles below Gillies depot. Cobalt camp is now using about 20,000 horse-power.

The Miller Lake-O'Brien mine, Gowganda, is developing about 500 horse-power on the east branch of the Montreal river, between Gowganda and Burke lakes.

The tonnage of ore milled during the year showed an increase of 46 per cent. compared with 1912. An 80-stamp mill was built by the Northern Customs at Mileage 104, one mile north of Cobalt. The Beaver, Cobalt Lake and Casey Cobalt companies doubled their milling capacity during the year, and the McKinley-Darragh-Savage company added twenty stamps to their 30-stamp mill. The Buffalo Mines completed a mill for high-grade ore.

Concentrating Plants

The concentrating plants and their capacity are shown in the following table:

Mill	Capacity per day, Tons.	No. of Stamps.	Method of Treatment.
Beaver	90	Crushing by rolls	Concentration.
Buffalo	250	" "	Concentration and cyaniding.
Cobalt Lake	150	40	Concentration.
Cobalt Reduction	335	120	"
Colonial	25	10	"
Coniagas	180	60	"
Dominion Reduction	175	40	Pan amalgamation, concentration and cyaniding.
Hudson Bay	70	20	Concentration.
King Edward	30	10	"
McKinley—Darragh-Savage	200	50	"
Nipissing	240	40	Cyaniding.
Nipissing Reduction	70	Crushing by rolls	Concentration.
Northern Customs	225	80	"
O'Brien	140	30	Concentration and cyaniding.
Penn-Canadian	75	Crushing by rolls	Concentration.
Silver Cliff	75	" "	"
Temiskaming	130	40	"
Trethewey	110	30	"
Outlying Camps.			
Casey Cobalt	90	30	"
Miller Lake—O'Brien	30	10	"
Wettlaufer	30	Crushing by rolls	"
Totals	2,720	610	

Labor

There were no labour troubles in Cobalt and vicinity during 1913. The number of men employed was about 500 more than last year. There was a very marked difference in the supply of labour at the beginning of the year compared with the latter months, there being a scarcity of even unskilled labour during the first nine months of 1913. Skilled English-speaking miners can always obtain employment, although during the winter 1913-14 there was a surplus supply of unskilled labour.

Twelve men were killed in Cobalt during the year; ten of these fatalities occurred underground and two on the surface. Two men were killed underground in Gowganda. This is an increase of five over the preceding year.

On January 1st, 1914, the Eight-hour Act came in force in the mines of this district. This Act calls for eight hours work underground—from face to face. The only difficulty which arose from the change in hours was at the Coniagas mine, where the management continued the nine-hour day, allowing and paying the men for one hour going to and from work. A strike resulted, but was shortlived.

Cobalt Silver Mines

Aladdin

The Aladdin Company own and operate the old Silver Queen mine, employing an average of 16 men. Captain Conrad Jorgensen is president, and Mr. J. A. McVichie is manager. Ore amounting to 1,898 tons was milled at the Nipissing Reduction Company's works, which were leased by the Aladdin. This ore produced 57.212 tons of concentrates, of which 31.5 tons were shipped, yielding 19,511.4 fine ounces of silver.

Bailey

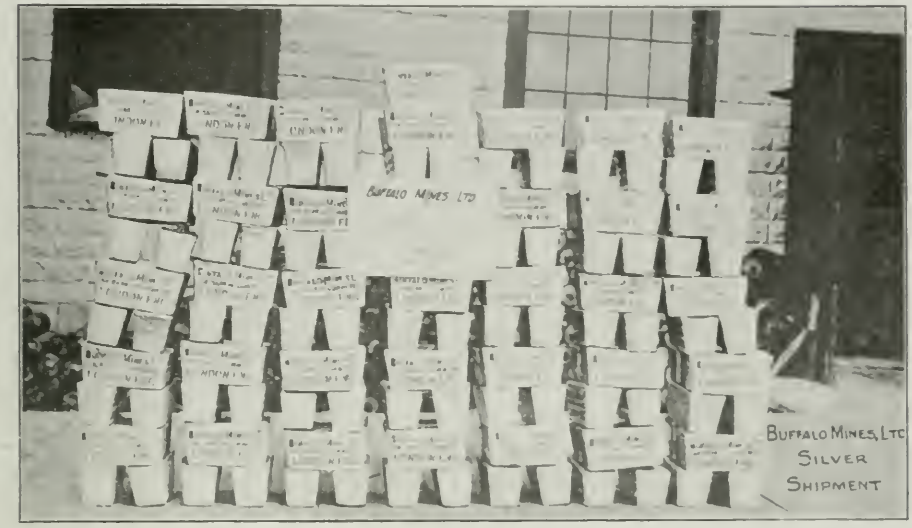
The Bailey Cobalt Mines, Limited, under superintendent Floyd Weed, carried on work during the year on the southwest quarter of the north half of lot 4 in the fourth concession of Coleman, adjoining the Penn-Canadian mine. Mr. G. A. Benson is president and treasurer of the company.

The following table shows the development work during the year:

	Drifts.	Cross-cuts.	Raises.	Shafts.
	feet.	feet.	feet.	feet.
1st level	111	146	....	....
1st sub-level	117	47	72	....
2nd sub-level	....	107	....	....
2nd level	255	28	16	....
3rd sub-level	92	....	72	....
4th level	65	14	....	4
4th sub-level	140	24	9	....
Shaft	....	....	....	52
Totals	780	366	169	56
Total development	1,371 feet			

Beaver

The Beaver mine, situated on the north half of the northwest quarter of the north half of lot 1 in the third concession of Coleman, is owned and operated by the Beaver Consolidated Mines, Limited, which have an authorized capital of 2,000,000 shares of a par value of $1.00 each. The officers are as follows: Frank L. Culver, president and general manager; C. C. James, vice-president; H. E. Tremain, secretary-treasurer.



Shipment of Silver Bullion from Buffalo Mine

New High-Grade Mill at Buffalo-Mines, Limited

During the year the capacity of the concentrator was increased by the addition of a larger ball mill to 100 tons per day. A new Nordberg hoist was purchased, capable of lifting 8,000 lb. from a depth of 2,000 feet at a speed of 1,800 feet a minute. As soon as the hoist is installed the shaft will be continued to the 900-foot level.

Underground work during the year was as follows:

Drifting	3,222.5 feet
Cross-cutting	916 feet
Sinking	96.5 feet
Raising	287.5 feet
Total	4,522.5 feet

Stoping—4,685 sq. yards.

Station cut at the 800-foot level.

The main shaft is now down 820 feet. On the 460-foot level two veins of high-grade ore were cut in the granite formation.

During the year the mill operated 293½ days and treated 25,256 tons of ore. The heads averaged 18.6 oz. silver and the tails 3.65 oz.

One dividend of $60,000 was paid during the year.

This company during the past two years have been paying particular attention to safety, both above and below ground, and have a thorough system of inspection. During the year only one accident occurred, and that a minor one.

Buffalo

This mine, situated on the townsite of Cobalt, is owned and operated by the Buffalo Mines, Limited, which have an authorized capital of $1,000,000, the shares having a par value of $1.00.

The officers of the company are as follows: Mr. Chas. L. Denison, president; Mr. Robt. W. Pomeroy, vice-president; Mr. Geo. C. Miller, secretary-treasurer; Mr. Tom R. Jones, general superintendent; Mr. E. W. Jones, assistant superintendent.

The development work during the year was as follows: Drifting, 1,979 feet; raising, 92 feet; stoping, 62,844 square feet. Operations underground were practically on the same plan as in former years.

The low-grade mill treated 71,042 tons; the cyanide plant, 11,744 tons; the high-grade mill, 1,116 tons of high-grade ore and concentrates. From the high-grade ore and concentrates treated at the high-grade plant, 1,668,763 fine ounces of bullion were recovered and shipped. A shipment was also made of 57 tons of concentrates, which returned 83,436 fine ounces of bullion, giving a total of 1,752,199 fine ounces of silver bullion shipped during the year.

Casey Cobalt

This property, situated on the southeast quarter of the south half of lot 5 in the first concession of Casey township, about 10 miles northeast of the town of New Liskeard, is controlled by the Casey Cobalt Mining Company, Limited, with an authorized capital of $100,000. The company was an important producer during 1913.

A 30-stamp mill is in operation. A power line has been built from New Liskeard and the plant is now electrically driven.

Mr. N. R. P. Parker is president; Mr. John Shaw, manager.

Chambers-Ferland

The Chambers-Ferland Mining Company, Limited, continued operations in the old No. 1 and No. 2 shafts, adjoining the La Rose and O'Brien, but the chief development during the year was the sinking of No. 4 shaft to a depth of 304 feet, on their territory west of the railway. The officers of the company are as follows: Captain C. Jorgensen, president; Mr. Arthur Ferland, vice-president; Mr. Alex. Fasken, secretary-treasurer; Mr. J. A. McVichie, manager.

Surface Plant, Casey Cobalt Mine

Surface Plant, Porcupine Crown Mine

At the Nipissing Reduction Company's works 8,886 tons of ore were milled, yielding 57.898 tons of concentrates, containing 50,401 fine oz. of silver. In addition, 172.264 tons of ore, containing 19,066.27 fine oz. of silver, were shipped to smelters.

Following is a summary of the development work done during the year:

Sinking	359 feet
Raising	168 feet
Drifting and cross-cutting	790 feet
Stoping (all in No. 1 mine)	2,595 tons

City of Cobalt

The control of the City of Cobalt Mining Company was purchased early in the year by interests allied with the Cobalt Townsite Mining Company.

The new officers are as follows: J. P. Watson, president; W. R. P. Parker, vice-president; C. E. Watson, manager.

The development during the first five months of the year consisted of about 1,000 feet of drifting and cross-cutting, about 100 feet of raising, and the deepening of the shaft from 330 to 400 feet. The development under the new management, from June 7th to December 31st, 1913, comprised: drifting, 548 feet; cross-cutting, 830 feet; raises, 196 feet.

A new 9 by 12 single drum hoist was installed.

Cobalt Comet Mine

During the year the Drummond mine was sold to the Cobalt Comet Mines, Limited, the new owners taking possession on March 31st. It is now known as the Cobalt Comet mine. The portion of the property underlying Kerr lake was subsequently sold to the Kerr Lake and Crown Reserve companies, who are operating it under the name of Drummond Fraction. The area of the fraction is about seven acres and the area of the Cobalt Comet about 71 acres. The Cobalt Comet is controlled by the Caribou-Cobalt Mines Company.

The property is operated through two shafts, No. 1 and No. 5, which are 140 feet and 200 feet deep respectively. No. 5 shaft is equipped with an electric hoist and cage, and No. 1 with a steam hoist and skip. The shafts are connected by drifts underground. There is a total of 8,915 feet of development.

The low-grade ores are shipped over the aerial tramway to the Dominion Reduction Company's mill and by rail to the Northern Customs Concentrators. The high-grade ore is sold to the Nipissing high-grade mill. The total output for the year was about 15,500 tons.

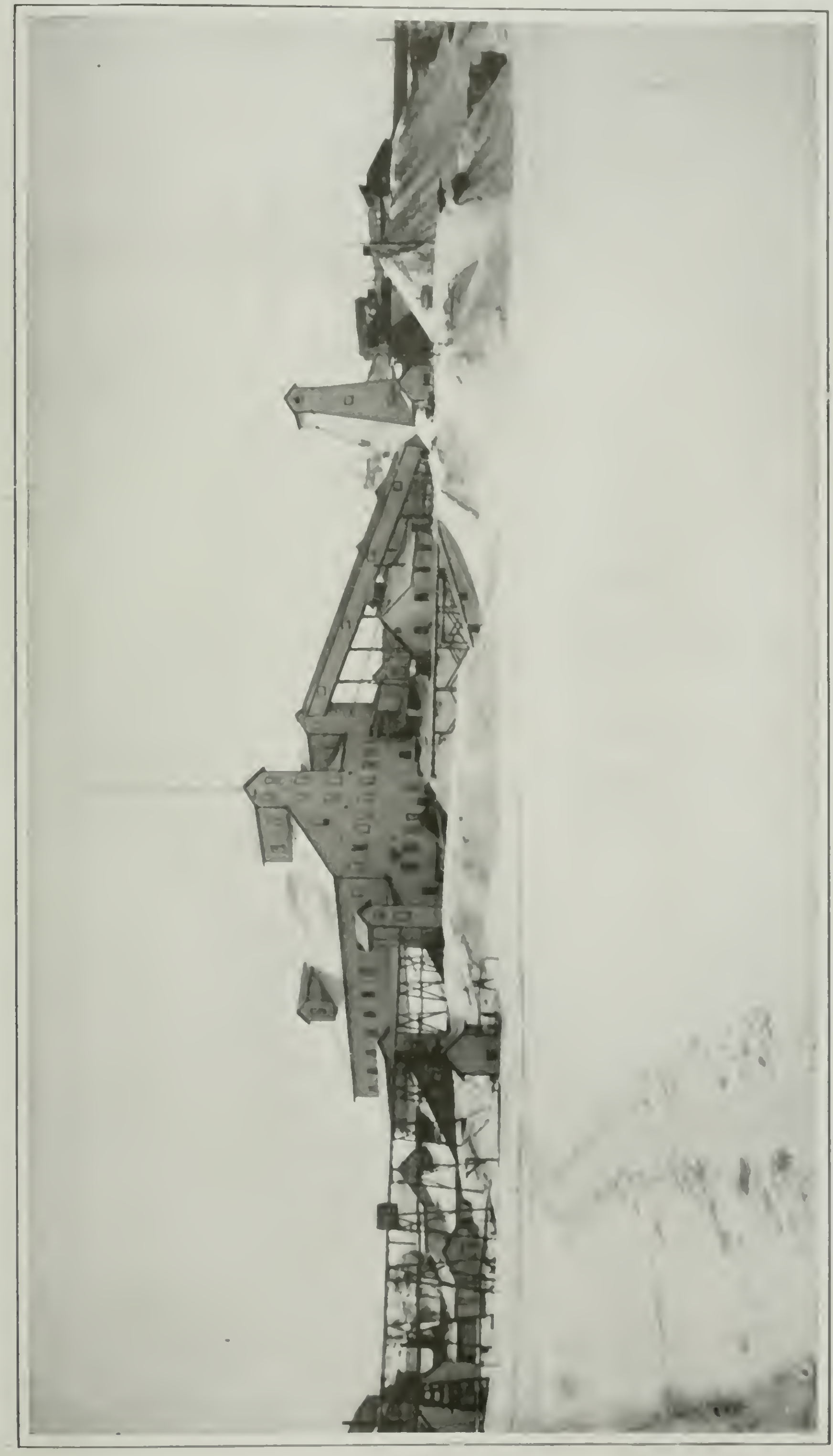
Mr. E. V. Neelands is manager of the company and 60 to 70 men are employed.

Cobalt Lake

Cobalt Lake Mining Company, Limited, own and operate the bed and margin of Cobalt lake. The officers of the company are as follows: Sir Henry Pellatt, president; Major J. A. Murray, vice-president; Messrs. W. R. P. Parker, Hugh Blain, J. F. Watson, directors; G. F. Morrison, secretary-treasurer; M. B. R. Gordon, manager.

The manager reports the following underground work during the year: Drifting, 1,570 feet; cross-cutting, 1,442 feet; raises, 285 feet; winzes, 98 feet; shafts, 14 feet; stoping, 423,449 cu. feet.

The exploratory work opened up two new enriched areas, viz.: vein No. 1, and vein system No. 2. Vein No. 1 was encountered by a cross-cut driven west along the McKinley-Darragh-Savage boundary line, and has been drifted on at the 225-foot level for a distance of 320 feet to the Townsite Extension boundary. At this level it was entirely in the Keewatin, the conglomerate lying from 15 to 20 feet above. Four raises were driven from this level, and each one encountered good ore on reaching the conglomerate. The opening up of vein system No. 2 has been the greatest success during



40-Stamp Mill of the Cobalt Lake Mining Company, Limited the year. A total of 600 feet of drifting has been done on these veins. Vein No. 1 runs parallel to a fault along which the rock is much fractured, permitting extensive seepage from the lake above. Very little stoping is being done here until after the lake is drained.

On December 23rd, 1913, Mr. T. E. Godson, Mining Commissioner, made an award, granting the company permission to drain the lake. This work will probably be carried out during the coming year.

During the year the size of the mill was doubled by the addition of twenty stamps, at a cost of $45,000.00, and the new stamps were put in operation towards the end of May.

The mill treated during 1913 a total of 37,616 tons of ore, with an average silver content of 25.4 ozs. per ton. From this tonnage, 1,000.4 tons of concentrates were produced, containing a total of 803,543 ozs. of silver. The mill was run 309 days, at a net cost for operation and maintenance of $54,764.20.

The total output of the mine for the year was 973,676 oz. of silver.

Cobalt Townsite

The Cobalt Townsite Mining Company, Limited, with an authorized capital of $100,000, hold a 99-year lease from the Temiskaming and Northern Ontario Railway Commission of the south 38 acres of the townsite of Cobalt.

Mr. W. R. P. Parker, of Toronto, is president; J. P. Watson, vice-president; R. Simpson, secretary-treasurer; C. E. Watson, manager.

The development during the year consisted of 2,183 feet of drifting; 3,559 feet of cross-cutting; 603 feet of raising and 162 feet of sinking.

The Northern Customs Concentrators, which previously treated the company's ore under contract, was purchased and taken over on November 1st.

Colonial

The Colonial Silver Mines, Limited, operated the mine and mill during January and February, 1913. The mill was leased to the Right of Way Mining Company, and that company's ore was treated there during the last seven months of the year.

A small amount of work was done on the 350-foot level of the mine during the last quarter of the year.

Coniagas

The Coniagas Mines, Limited, having an authorized capital of 800,000 shares of a par value of $5.00, own and operate the Coniagas mine, consisting of 40 acres on the townsite of Cobalt, and the issued capital stock of the Coniagas Reduction Company, Limited. The Board of Directors is as follows: R. W. Leonard, St. Catharines, president and general manager; Alex. Longwell, Toronto, vice-president; R. P. Rogers, Cobalt; F. J. Bishop, Brantford; Welland D. Woodruff, St. Catharines.

During the year $1,640,000 was paid in dividends.

The assistant to the president reports that during the year the following underground work was done:

Drifting	2,160 feet
Cross-cutting	1,655 feet
Winzes	77 feet
Raises	104 feet
Stoping	47,370 tons

The mill ran 98 per cent. of possible time, treating 54,890 tons, or an average of 2.95 tons per stamp per 24 hours. The mill heads averaged 28.3 oz. per ton; the average of the general tails was 4.23 oz.

During the year lot No. 290, of which the company own the mining rights, was purchased, and six acres adjoining the westerly boundary of the property were leased, in order to secure suitable sites for employees' houses.

Crown Reserve

The Crown Reserve Mining Company, Limited, with an authorized capital of 2,000,000 shares, par value of $1.00 each, own and operate the Crown Reserve mine at Cobalt, work the Silver Leaf mine under lease, own and hold 60 per cent. of the entire capital stock of the Porcupine Crown mine, Porcupine, and, in conjunction with the Kerr Lake Mining Company, own the water lots on Kerr lake formerly owned by the Drummond, along with a strip of land 33 feet wide around this end of the lake above the high water mark.

The officers of the company are:—Lieut.-Col. John Carson, president; Mr. W. J. Gear, first vice-president; Mr. C. E. Potter, second vice-president; Mr. James Cooper, secretary and treasurer; Mr. John Reid, assistant secretary-treasurer; Mr. S. W. Cohen, general manager.

The underground work during 1913 is shown in the following table:

	Up to 1913.	1913.	Total.
Sinking and raising	2,222 ft.	288 ft.	2,510 ft
Drifting	7,220 ft.	2,558 ft.	9,778 ft.
Cross Cutting	7,356 ft.	2,499 ft.	9,855 ft.
Total	16,798 ft.	5,345 ft.	22,143 ft.

Stoping in cubic feet	1913	394,489
Stoping in square feet	do.	63,224
Tonnage broken	do.	56,982 tons.

During the year 29,543 tons of ore were milled by the Dominion Reduction Company for this company from which 525,312 ounces of silver were recovered; 1,253,296 ounces of silver were produced in high-grade ore. The total production to January 1st, 1914, was over 17,000,000 ounces, and over five and one-half million dollars have been paid in dividends.

Regarding the draining of Kerr lake, the annual report of the Crown Reserve Mining Company for 1913 gives the following information:

Permission having been granted on May 1st, 1913, by the Mining Commissioner of Ontario to the Crown-Reserve Mining Company, Limited, and Kerr Lake Mining Company, Limited, jointly, to pump out the water and mud from the bed of Kerr lake, construction work was immediately begun. The method of procedure follows:—

A 100-ton barge was constructed on which were installed four single-stage pumps, each with a capacity of 1,800 gallons of water per minute, arranged in two units, each unit being directly connected to a 250 H.P. motor; the pumps having a 12-inch suction and a 10-inch discharge. At the beginning, as long as fresh water was being pumped and the head was not excessive, the pumps were operated in parallel, that is, each pump discharged independently into the main discharge line. Later, against the greater head, and when the pumps were working on mud, the pumps were operated in series, that is, there was one suction for each unit, the water going from the first pump into the second pump, and then into the discharge line. The whole installation is very elastic, and adapted to any changes made necessary by new conditions. The barge was first anchored near the shore of the lake, and as the water was lowered, it was floated out to the middle of the lake, the connection between the shore and the barge being made by two universal ball and socket joints, and an expansion and contraction joint supported on floats.

A 20-inch pipe line was installed from the shore of Kerr lake for a distance of 2,500 feet, where it discharged directly into Giroux lake, from whence it empties into the Montreal river.

Pumping was actively begun on August 28th, and four weeks thereafter most of the clear water had been pumped out, leaving the silt and mud still to be handled, and lowering the lake 28 feet. From that time until the freeze-up of November 28th, good progress was made in pumping the mud, although the rate of pumping was much less than the handling the water. It was found that there was an average of 25 feet of mud and silt over the whole lake after the clear water had been removed. In all, 325,000,000 gallons of water and mud were pumped out, the lake being lowered a total depth of 38 feet. The operation of pumping the mud will be renewed as early as possible in the spring, and during the next summer, all of the mud should be removed. It may be necessary in connection with this work to put in some kind of a sluicing plant to wash all of the mud into the sump in the middle of the lake, but the cost of such a plant will be nominal.

The total cost of plant installation, including a fresh water plant on Giroux lake, capable of handling 1,000 gallons per minute, was

For the distribution of fresh water	$39,604.76
The total operating cost to date is	12,078.29
The total expenditure to date is	$51,683.05

Drummond Fraction

The piece of ground, about six acres in extent, comprising the extreme easterly portion of Kerr lake, previously owned by the Drummond mine, together with a strip 33 feet wide around that portion of the shore of the lake, and carrying with it all mining, surface and water rights, was purchased jointly by the Kerr Lake Mining Company, Limited, and the Crown Reserve Mining Company, Limited, during 1913, and is now being operated by the joint owners.

After the lake was lowered, a high-grade vein averaging two inches in width, together with four or five feet of good milling ore, was opened up on the surface for a length of 60 feet. Arrangements were made with the Cobalt Comet Company, the present owners of the Drummond property, for the rental of the Wright shaft, and a cross-cut was driven from this shaft at the 100-foot level to the vein below. A shaft house, ore house and other necessary buildings were constructed, and the property is now producing milling ore.

Mr. Mark Little is in charge.

Gould

Mr. J. G. Sipprell, manager of the Gould Consolidated Mines, gives the following account of their development:

The cross-cut was driven out from No. 1 shaft a distance of 214 feet S. 36 degrees E., parallel to the boundary line of the Gould and Seneca-Superior. Nothing of importance was cut, consequently at 200 feet from the shaft in this cross-cut a drift was started in the trend of the vein toward this boundary. After extending this a distance of 278 feet high-grade ore was cut near the boundary. This vein proved to be an extension of the Seneca-Superior vein, and was from one and three-quarters to two inches wide at this point.

All the recent work has been done in the conglomerate at the 200-foot level. No. 1 shaft, down to a depth of 167 feet, is in the conglomerate. At this point the slates dipping at 15 degrees to the northeast are encountered, and continue in the cross-cut on the 200-foot level a distance of 153 feet, when the face has gradually come into conglomerate, which remains through the rest of the workings.

A 10-ton shipment was made in December.

Hargrave

The Hargrave Silver Mines have an authorized capital of $2,500,000. The officers of the company are:—Mr. W. N. Ferguson, president; Mr. R. J. Tough, vice-president; Mr. R. D. Moorhead, secretary-treasurer; Mr. E. V. Neelands, manager.

The development during the year was as follows:—

Drifting	505 feet.
Cross-cutting	244 "
Raising	350 "
Sinking	30 "

In view of the unsuccessful results attending the year's developments, it was decided by the directors to suspend operations, and all work ceased December 31st.

Hudson Bay

This property consists of 340 acres, situated in the township of Coleman, and is operated by the Hudson Bay Mines, Limited, whose capitalization is 3,500,000 shares of a par value of $1.00 each. Of this amount, 2,900,000 shares are owned by the Temiskaming and Hudson Bay Mining Company, Limited, which have an authorized capital of $25,000, of which 7,761 shares have been issued. The latter company paid $192,003 in dividends during their fiscal year, 1912-13.

The officers and directors of the company are as follows:—Mr. Geo. Taylor, president; Mr. A. A. McKelvie, vice-president; Messrs. S. S. Ritchie, Jr., T. McCamus, J. J. Grills, C. L. Sherrill, D. M. Ferguson, directors; F. L. Hutchinson, secretary-treasurer; A. H. Brown, general manager.

The development during the year was as follows:—

Drifting	173.8 feet.
Cross-cutting	269.8 "
Adit from surface	35.2 "
Raising	41.1 "
Sinking winze	121.4 "

The mill treated 22,285.6 tons carrying 466,698.8 ounces of silver. The ratio of concentration was 35 to 1. The total silver production was 659,972.19 ounces. A small sum was realized for the copper content of the concentrates.

A fire in July destroyed part of the surface equipment, but caused little delay in mining operations.

At camp No. 2, south of McKinley-Darragh mines and east of the Temiskaming and Northern Ontario railway, 851 feet of drifting was done in exploring the Cobalt lake fault. A new head-frame, blacksmith shop and hoist were installed at the head of No. 2 shaft on this property.

At the Gowganda property of this company the development for the year was as follows:—

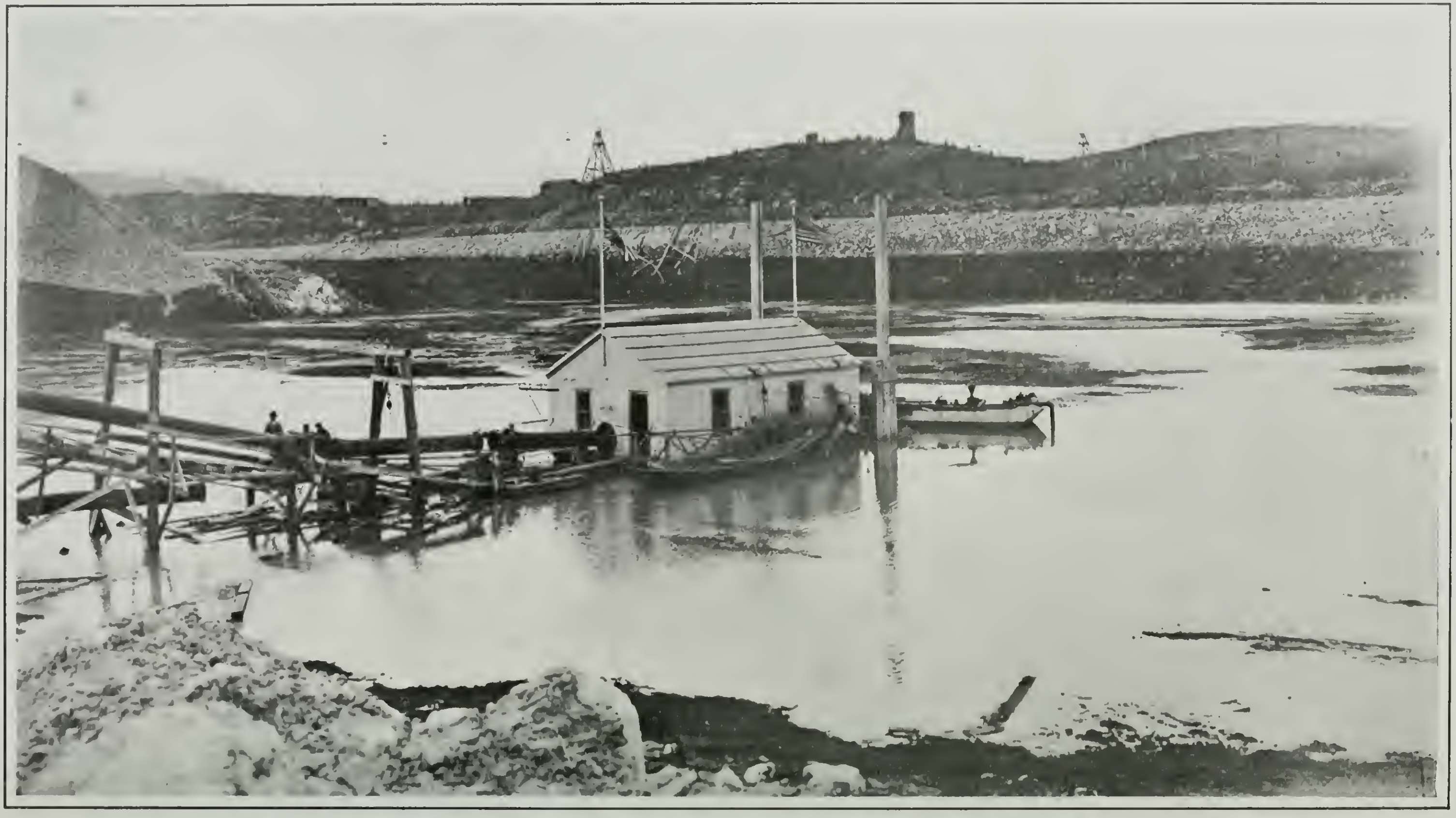
Sinking on No. 1 shaft	94.0 feet.
Drifting in No. 1 shaft	128.0 "
Sinking No. 3 shaft	78.0 "
Drifting on 1st level	88.0 "
Drifting on 2nd level	169.0 "
Cross-cutting on 2nd level	220.0 "

Development work not being encouraging, this mine was closed down in July.

Surface work was done on the company's claims in Lebel and Teck townships.

Kerr Lake

This mine is situated on the northwest part of lot 4, in the fourth concession of Coleman, and it is operated by the Kerr Lake Mining Company, Limited, which have an authorized capital of $40,000. The capital stock of the company is held by the Kerr Lake Mining Company, of New York, with an authorized capital of 600,000 shares of a par value of $5.00 each.



Pumping Out Kerr Lake

—Photo by Arthur A. Cole.

The officers of the company are as follows: Mr. William C. Nickerson, president; Mr. William P. Ward, vice-president; Mr. E. H. Westlake, secretary-treasurer; Mr. Robert Livermore, manager.

The underground development during the year closing September 1st, 1913, was as follows:—

Drifting	2,974.0 feet.
Raising	160.5 "
Sinking	186.0 "
Cross-cutting	1,663.5 "
Total	4,984.0 feet.
Stoping	38,716.0 sq. feet.

The total development to date is 34,663 feet.

The manager states that the most important development of the year was on the Flemming vein on the 225-foot level. At this level the vein is in Keewatin formation; and here a good amount of second-grade ore and mill rock was opened up with occasional shoots of very high-grade ore.

In consequence of the growing importance of ore of milling grade it has been found necessary to carry the stopes much wider than formerly, and the square-set method of timbering has been adopted.

Eighteen thousand two hundred and fifty-two tons of ore, averaging 29.29 ounces in silver, were treated at the mill of the Dominion Reduction Company. In addition to this, 183,682 ounces of silver were recovered in the company's ore-sorting plant. Altogether 2,109,975 ounces of silver were produced, and $600,000 paid in dividends during the year. The dividends to date amount to $4,620,000.

As mentioned before in this report, this company, in conjunction with the Crown Reserve Mining Company, drained Kerr lake, and purchased lots J.B. 9 and 10, together with 33 feet on the shore from the Drummond mine. The draining of Kerr lake exposed a remarkable vein of high-grade ore on the Kerr Lake Mining Company's property.

La Rose Consolidated

La Rose Consolidated Mines Company, Limited, operate the following mines:— La Rose, Lawson, Princess, Violet, University and Fisher-Eplett. Mr. D. Lorne McGibbon is president and Mr. R. B. Watson manager.

The production during 1913 was 2,636,000 ounces of silver. The average cost of production was 22.8 cents per ounce, leaving a profit of 36.52 cents per ounce on the shipments. The cost of production was 3.13 cents per ounce less than in 1912, and the price received for silver 2.34 cents less.

The net profit was $955,418.27, or 61.38 per cent. of the gross value of the ore. The dividends declared for the period amount to $931,000.

The production of the several properties was as follows:—

	Dry tons.	Oz. silver.	Net value.
La Rose	1,313.1235	578,933.31	$295,991.16
Lawson	366.0075	708,936.59	395,624.66
Princess	685.4945	909,608.23	499,935.95
Concentrates	958.9430	436,538.02	218,082.77
Total	3,323.5685	2,634,016.15	$1,409,634.54

Following are details of concentration:—

Ore milled	37,555.959 dry tons.
Silver contents heads	508,288.26 oz.
Average assay heads	13.53 oz. per ton.
Concentrates produced	950.142 tons.
Silver contents concentrates	437,439.41 oz.
Average assay concentrates	460 oz. per ton.
Net value of concentrates	$217,924.17.
Cost of concentration	$102,447.54.
Cost per ton, ore milled	$2.73.
Profit to La Rose Mines, Limited	$115,476.63.
Average tonnage for 313 days	120 tons per day.
Ratio of concentration	39.521.

The above ore was milled at the old plant of the Northern Customs Concentrators. All ore for the current year will be treated at their new plant.

The tons of mill rock supplied by each mine were:—

La Rose	15,388 tons.
Lawson	4,818 "
Princess	17,350 "
Total	37,556 tons.

The annual report of the manager gives the following summary of development at the several mines:—

La Rose mine.—Considerable exploration was done in the bottom of the mine. A cross-cut at a depth of 500 feet below the collar of the main shaft was run to the fault, and 130 feet of drifting was done. This work developed a large calcite vein along the fault which, however, carried only a small amount of silver. An incline shaft was then sunk on the fault for a distance of 233 feet below the 500-ft. level. Near the bottom, at a depth of 215 feet, drifts were run both ways for a combined distance of 80 feet.

The exploration on this large calcite vein in the fault did not produce any pay ore, so work on and below the 500-ft. level was discontinued. Exploration is now centred on the 380-ft. level, which is in the conglomerate just above the Keewatin contact; cross-cuts are being driven in three directions on this level.

Lawson mine.—The chief work at the Lawson has been in stoping on the ore shoots already known.

No. 8 shaft has been sunk to the 400-ft. level, and the main vein is to be explored at this depth.

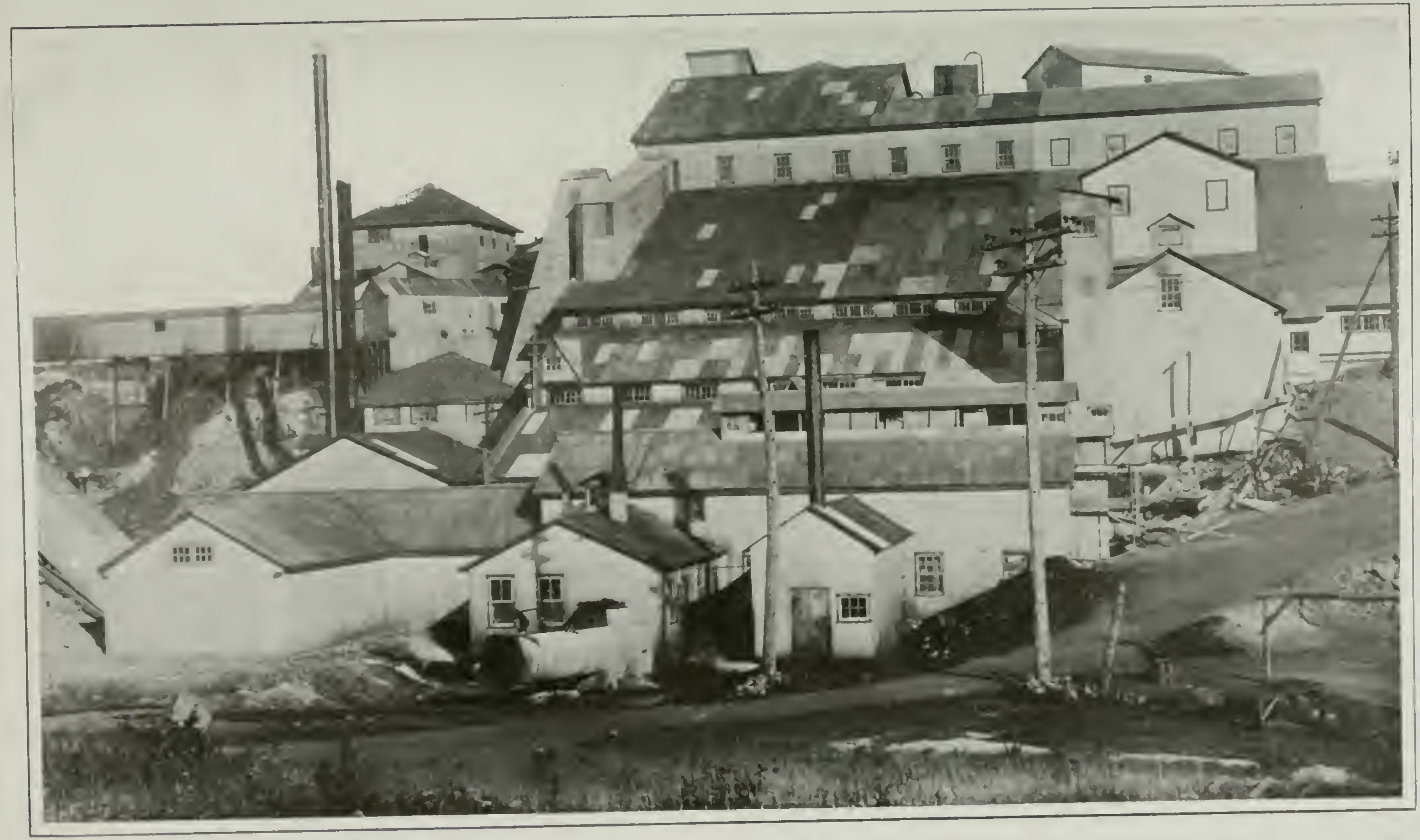
Princess mine.—More development work was done on this claim than on any of the others, and resulted in the finding of four veins.

A winze was sunk on No. 7 vein from the third, or 185-ft. level, down to the Keewatin contact, and the fourth level was driven at a depth of 225 feet. Some drifting was done on the Cobalt lake fault on the third level, but no more favorable results were obtained here than at the La Rose.

The Princess claim contains but seventeen acres, and has been well prospected above the contact.

Fisher-Eplett.—Work was carried on actively at this property throughout the year. The shaft was sunk to the 300-ft. level, where 696 feet of drifts and 561 feet of cross-cuts were driven, without finding any ore of commercial value.

A large flow of water somewhat delayed operations, but the situation is improving, and work will be continued to prospect the remaining territory.



50-Stamp Mill at the McKinley-Darragh Mine

Other properties.—Some cross-cutting was done on the Violet without success. No work was done during the year on the La Rose Extension or on the University. It is the intention to explore the latter claim from the Lawson workings.

Lumsden

The Lumsden Mining Company were operating the property situated on the west half of the northeast quarter of the north half of lot 2 in the third concession of Coleman. The main shaft is 400 feet deep, and the work was carried on mainly on the 225- and 250-ft. levels.

The president of the company is Mr. John Lumsden, Ottawa; the general superintendent, Mr. F. I. Daniels, Cobalt.

The following table shows the development during the year:—

Level.	Drifting	Cross-cutting	Sinking Winzes	Raising	Total	Stopes
feet	feet	feet	feet	feet	feet	cu. ft.
225	479	....	....	64	543	12,960
250	70	30	....	....	100	....
300	10	32	29	....	71	....
Totals....	559	62	29	64	714	12,960

McKinley-Darragh-Savage

The McKinley-Darragh-Savage Mines of Cobalt, Limited, own and operate the McKinley-Darragh mine at the southern end of Cobalt lake and the Savage mine on lot 3 in the third concession of Coleman east of Cart lake.

The board of directors consists of:—Mr. C. A. Masten, president, Toronto; Mr. Thos. W. Finucane, vice-president, Rochester, N.Y.; Mr. J. R. L. Starr, secretary, Toronto; Mr. Harper Sibley, treasurer, Mr. Joseph S. Hunn, assistant treasurer, Mr. Hiram W. Sibley, and Mr. W. L. Thompson, Rochester.

Mr. T. R. Finucane is manager.

During the year the mill at the McKinley mine was enlarged to a daily capacity of 225 tons, and the Savage sorting plant was closed down, mill ore from the Savage being conveyed to the McKinley mill by aerial tram.

The following table shows the underground work at the McKinley-Darragh mine during 1913:

Levels	Drifts	Cross-cuts	Raises	Stopes
feet	feet	feet	feet	tons
110	806.5	914	27.5	9,698
135	40.	....	....	3,158
150	1,216.5	964	298.5	15,088
200	109.5	54.5	9	8,571
225	....	....	....	397
240	57.5	23.5	....	668
250	673	352	164	577
Totals......	2,903	2,308	499	38,157

The distribution of underground work during 1913 at the Savage mine is shown in the following table:—

Levels	Drifts	Cross-cuts	Raises	Winzes	Stopes
feet	feet	feet	feet	feet	tons
90	....	73.5	....	....	....
140	1,101	1,130.5	196.5	77	3,137
180	73	....	12.5	....	231
190	94	544	71.5	28	2,010
200	16	11	....	....	....
210	....	....	22.5	....	....
240	73	21	18	....	152
245	....	....	37	....	54
Totals.......	1,357	1,780	358	105	5,584

During the year the mill treated 63,016 tons of ore, from which 1,446,252 ounces of silver were recovered.

Including metallics and high-grade ore, the production of silver during the year was 2,214,036 ounces, bringing the total up to January 1st, 1914, to 12,984,212 ounces.

Meteor

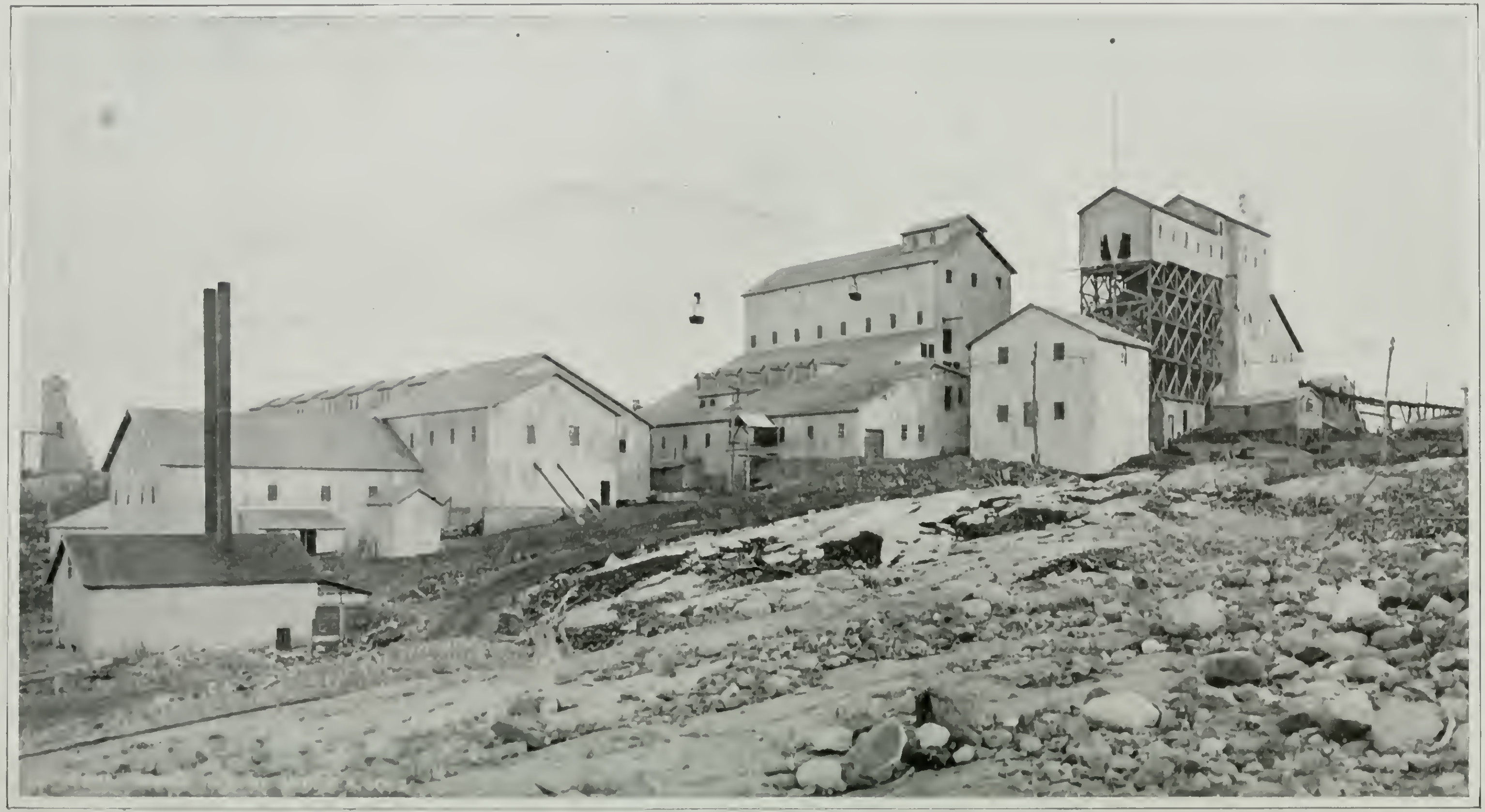
The Meteor Silver Mining Company have been working on their property on the northwest corner of Diabase mountain with a force of seventeen men. They have two shafts, one vertical 275 feet in depth, and one sunk on the incline under the mountain to a depth of 336 feet. The work done during the year consists of 50 feet of sinking; 42 feet of raising, 130 feet of cross-cutting, and about 200 feet of drifting.

A 25-h.p. boiler is used for heating purposes, and three small hoists run by air are in use.

Mr. D. D. Flanagan is manager.

Nipissing

The Nipissing Mining Company, Limited, with an authorized capital of $250,000, own and operate 846 acres in the township of Coleman, principally situated in the producing area. Mr. David Fasken, of Toronto, is president; Mr. R. B. Watson, general manager, and Mr. Hugh Park, manager. The Nipissing Mines Company is a holding company, owning all the stock of the Nipissing Mining Company, and have an authorized capital of 1,200,000 shares of a par value of $5.00 each. The officers and directors of the company are as follows: Mr. E. P. Earle, New York, president; Mr. R. T. Greene, New York, secretary; Messrs. W. H. Brouse, Toronto, Duncan Coulson, Toronto, David Fasken, Toronto, R. T. Greene, New York, M. A. Viele, New York, August Heckscher, New York, Dennis Murphy, Ottawa, and R. B. Watson, Cobalt, directors.



Nipissing Low-grade Mill —Photo copyrighted by Arthur A. Cole.

The general manager's report for 1913 shows the work done to be distributed as follows:

Shaft No.	Drifting	Cross cutting	Raising	Sinking	Total	Stoping
	feet	feet	feet	feet	feet	cub. yds.
8	242.0	271.0	103.5	9.5	626.0	289.0
63	1,148.5	375.5	232.5	....	1,756.5	2,322.0
64	173	592	....	225.5	990.5	245.3
73	2,287	2,798.5	848.0	70.0	6,003.5	28,407.9
80	257.0	217.5	32.5	....	507.0	11,762.1
86	474.0	402.5	40.5	105.0	1,022.0	....
92	176.5	72.0	....	....	248.5	421.3
122	572.5	436.0	49.0	....	1,057.5	570.1
150	791.0	662.0	....	....	1,453.0	....
Total.....	6,121.5	5,827.0	1,306.0	410.0	13,664.5	44,017.7

The general manager gives the following table of production of individual veins for 1913:

	Silver in High Grade Ore	Silver in Mill Rock	Total
	oz.	oz.	oz.
Vein 8....................................	1,091	....	1,091
Shaft 63 and Little Silver................	293,435	192,963	486,398
Shaft 73 : Veins, 64, 73, 80, and 100	2,147,515	1,767,828	3,915,343
Vein 96....................................	....	20,051	20,051
Vein 122..................................	104,677	4,367	109,044
Vein 128..................................	6,003	....	6,003
H 2, 5 and 35	14,243	....	14,243
	2,566,964	1,985,209	4,552,173

Surface prospecting by means of a hydraulic jet was carried on from May 3rd to December 6th. At night operations were conducted with the aid of a searchlight. The area cleared was 54.69 acres; the average depth of overburden, 3.9 feet.

Six diamond drill holes, aggregating 2,239 feet, were put down in the diabase area of R. L. 408.

Shaft No. 64 will reach the 900-foot level early in 1914, at which level it is intended to do considerable development work.

Regarding operations at the metallurgical plants of the company, the general manager in his annual report states:

High-grade Mill.—The reduction works for high-grade ore treated 1,200 tons of Nipissing ore, averaging 2,501 ounces per ton, and 632 tons of custom ores, averaging 2,854 ounces per ton. The precipitate from the low-grade mill was also sent to the high-grade plant for melting and refining. Total shipments of bullion during the year amounted to 6,530,871 fine ounces.

The residue from the high-grade mill carries 20 to 40 ounces silver, 8 to 10 per cent. cobalt, 4 to 6 per cent. nickel and 30 to 40 per cent. arsenic. This is sold to the manufacturers of cobalt products and during the year shipments of 1,659 tons were made, which netted the company $62,484.

The only new construction during the year consists of a baghouse for the fumes from the furnaces and retorts.

A great deal of research work has been carried on, with the object of improving the method for treating high-grade ore and concentrate produced in the Cobalt district.

By applying the principles successfully used in the reduction of low-grade ore, it is hoped that a method will be worked out whereby the higher grade ore can be treated to advantage by cyanide only.

Low-grade Mill.—The record for 1913 is as follows:

	Tons	Assay oz.	Silver oz.
Ore treated	77,133	27.182	2,096,611
By-products treated	107		54,383
Total milled	77,240		2,150,994
Bullion recovered from above			1,985,209

From the start of the mill, November 11, 1912, to December 31, 1913, the actual recovery has been 91.85 per cent.

All ore going to the mill is weighed on a registering beam scale and the contents of the ore is based on this weight and on an automatic sample of the 200-mesh pulp as it enters the cyanide plant.

New 80 Stamp Mill of Northern Customs Concentrators, Limited

Two features made possible the above extraction on these complex ores, which have heretofore resisted successful treatment by cyanide alone. One is the desulphurizing process originated at Nipissing, whereby the fine pulp is subjected to contact with metallic aluminum in a caustic soda solution. This treatment breaks up most of the refractory silver combinations and reduces the silver to the metallic state, so that it goes into solution easily in the subsequent treatment by cyanide. The other feature is the use of aluminum dust for precipitation instead of zinc dust. The resulting precipitate runs over 90 per cent. silver and is melted down into commercial bars 996 fine or better.

O'Brien

The following table shows the development in the several shafts during 1913, the greater part of which was done in the diabase:

	No. 1	No. 2	No. 6	Main	Total
	ft.	ft.	ft.	ft.	ft.
Raising and Sinking			144		144 lineal
Drifting and cross-cutting	102	219	1,959	320	2,600 "
Stoping					28,000 tons

A new tube mill and additional tanks which were added in the cyanide plant towards the end of the year increased the milling capacity by 1,000 tons per month; 40,000 tons were milled during 1913. The total production from high-grade ore, concentrates and bullion amounted to 1,212,013 fine ounces of silver.

Mr. M. J. O'Brien is owner, and Mr. R. H. James manager.

Penn-Canadian

The officers and directors of the Penn-Canadian Mines, Limited, are: Mr. W. J. Haines, president; Mr. R. B. Haines, secretary-treasurer; Mr. Spencer D. Wright, Mr. E. C. R. Laidlaw, Mr. Alfred S. Elliott. The general office of the company is at 1011 Chestnut street, Philadelphia, Pa.

The development work during 1913 was as follows: cross-cutting and drifting, 2,752 feet; raising, 326 feet; winzes, 47 feet; average number of men employed, 96.

During the year the mill treated 16,648 tons of Penn-Canadian ore and 3,156 tons of customs ore.

Mr. B. Neilly is general superintendent.

Peterson Lake

The Peterson Lake Silver Cobalt Mining Company, Limited, operate under Peterson lake, and lease to two other operating companies, the Seneca-Superior Mining Company and the Gould Consolidated Mining Company, portions of the bed of Cart lake. Sir Henry Pellatt is president, Mr. G. F. Morrison, secretary-treasurer, Mr. R. B. Lambe, consulting engineer, and Mr. W. C. West, manager.

The company were operating during the year in No. 1 shaft, situated near the narrows between Cart and Peterson lakes. Sinking in this shaft amounted to 217 feet and the total driving in three cross-cuts to 620 feet. At shaft No. 2, on the old Kerry lease, the mine was unwatered and the shaft repaired in preparation for the commencement of work. A new dry and an ore house were erected here.

Provincial

The Cobalt Provincial Mining Company, Limited, operated their property throughout the year, with an average force of eighteen men.

The officers are as follows: Mr. John F. Millken, president; Mr. John Redington, vice-president and general manager.

The development consisted of 90 feet of drifting and about 900 feet of cross-cutting.

Right of Way

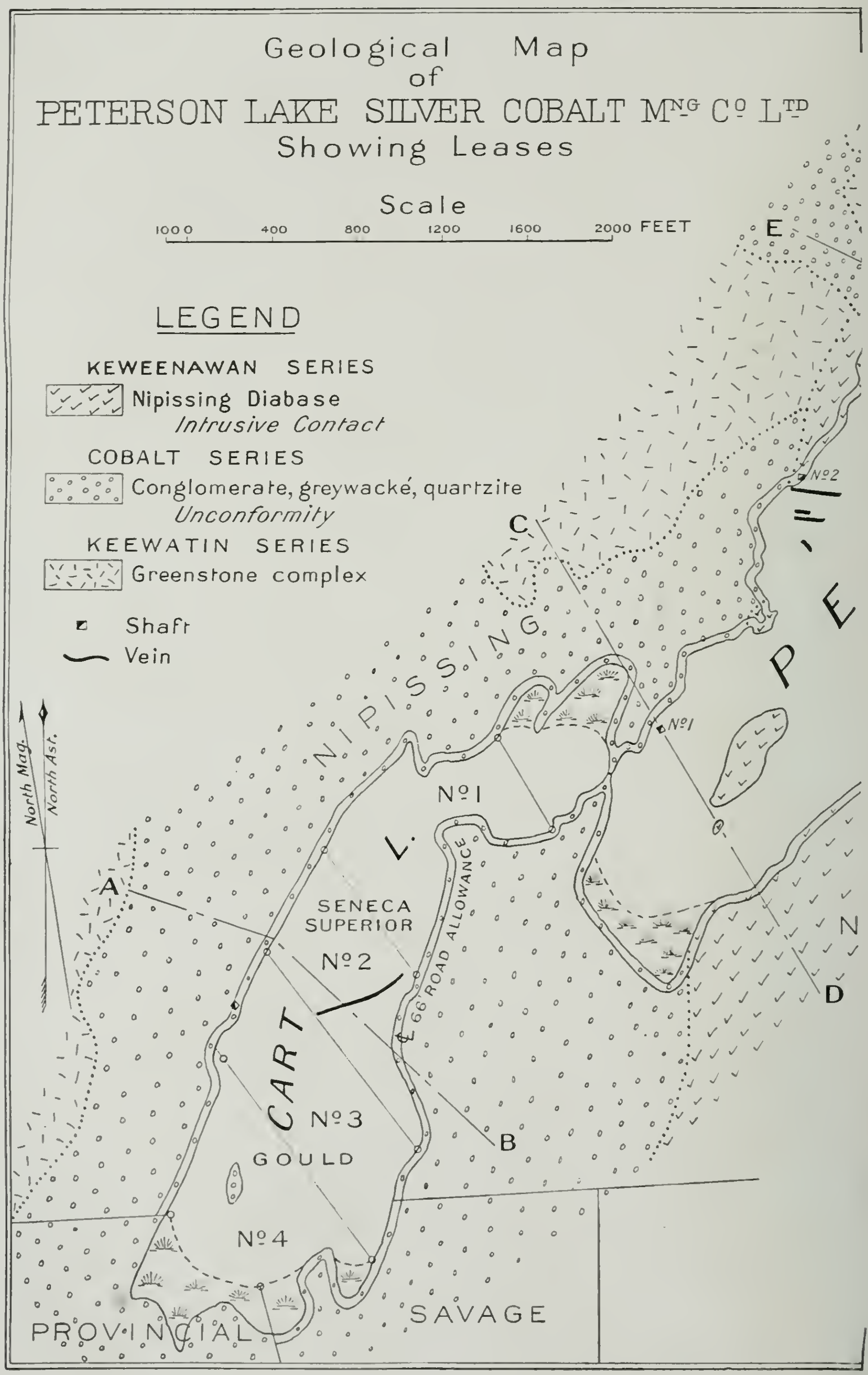
The Right of Way Mines, Limited, operated continuously during the year.

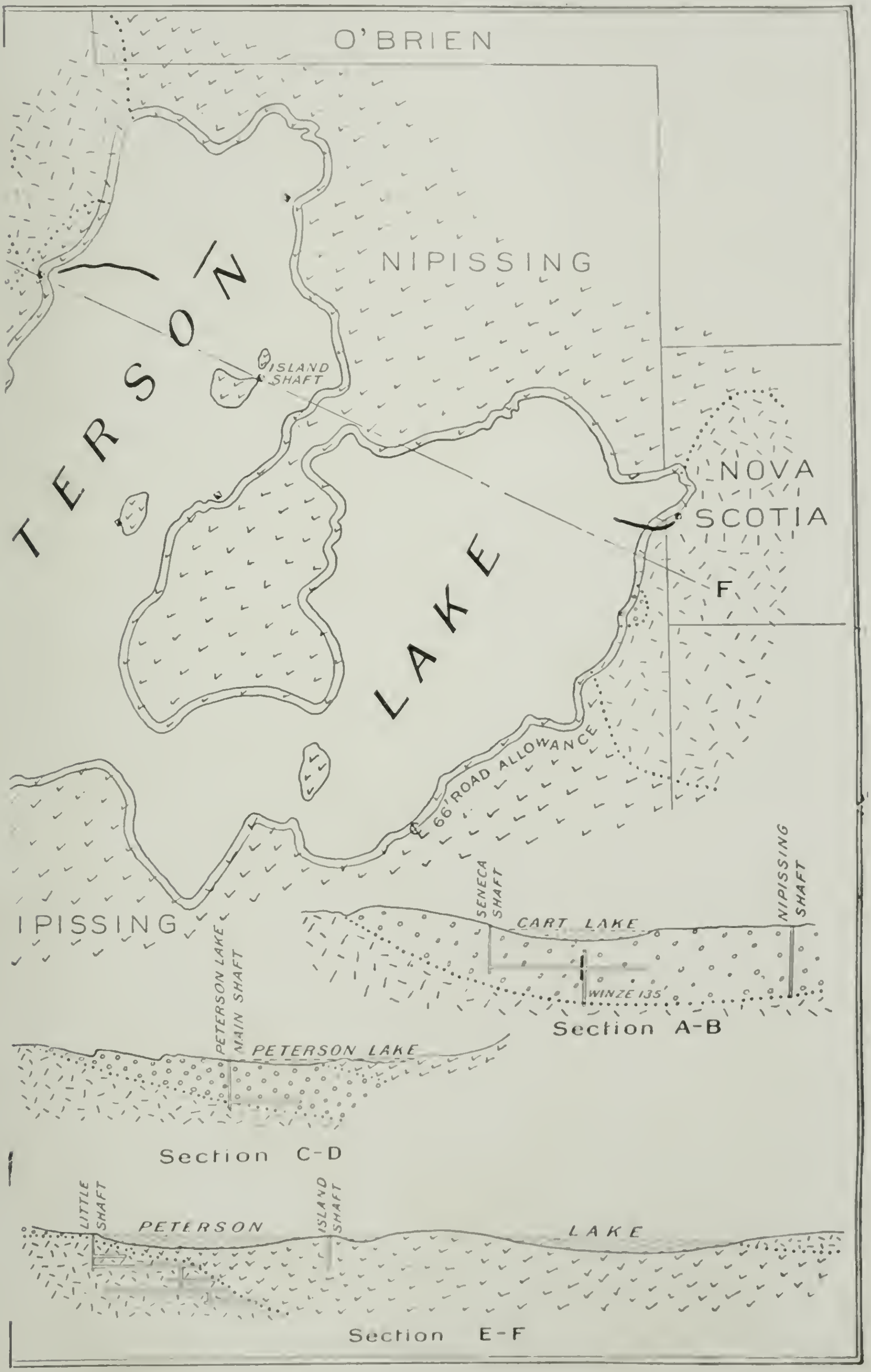
The underground work was as follows:

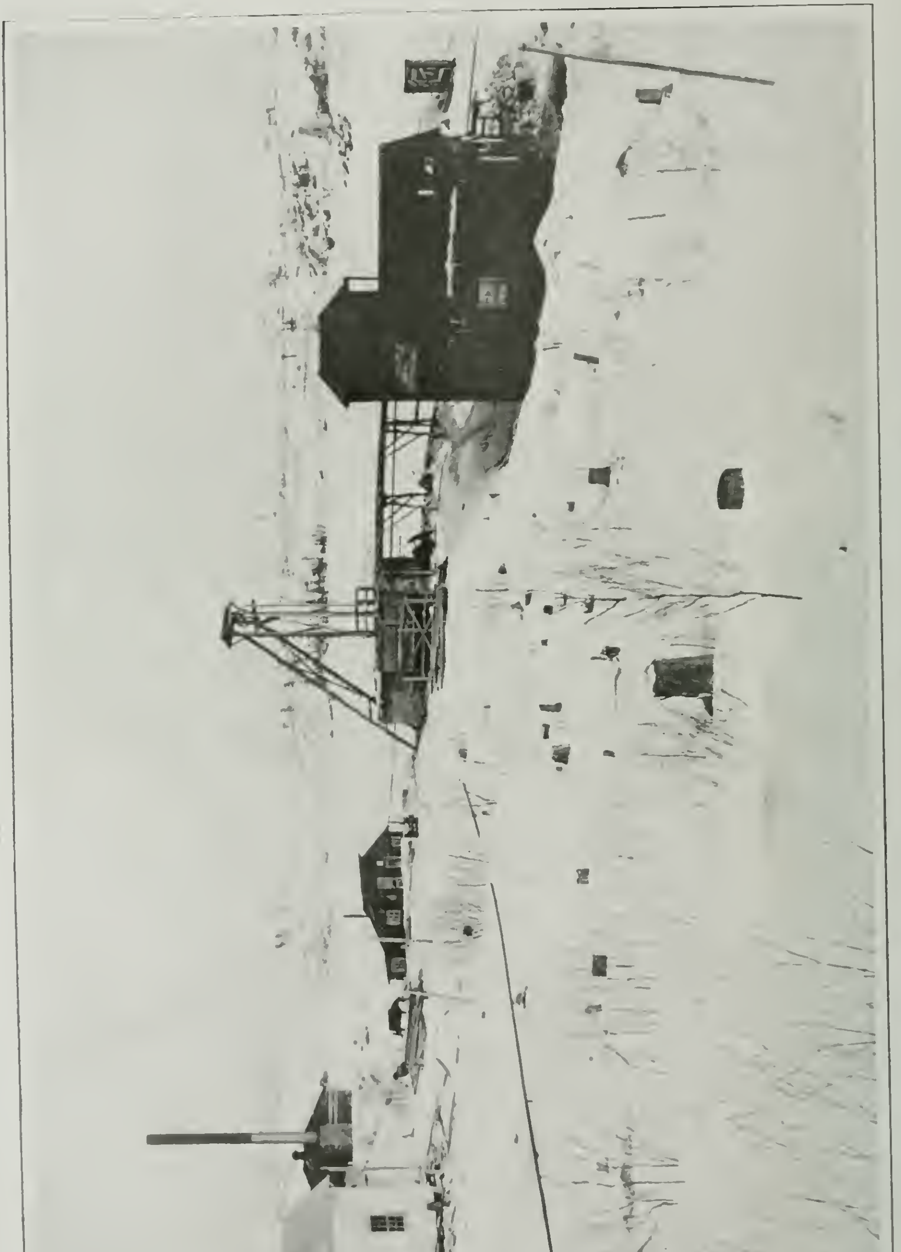
Sinking	225 feet
Cross-cutting	1,215 feet
Drifting	150 feet

No. 2 shaft, at the north end of Cobalt lake, was sunk from the 150-foot level to a depth of 375 feet, and a station cut at 365 feet; 650 feet of cross-cutting was done on this level. In December No. 3 shaft was unwatered, in order to prospect on the 120-foot level for the continuation of a vein found on the Princess property.

On July 1st the company rented the Colonial mill. The mill was operated 165.3 days and 5,013 tons of ore treated; 52,690 oz. of silver were recovered.


Geological Map
of
PETERSON LAKE SILVER COBALT MNG CO LTD
Showing Leases
Scale
1000 400 800 1200 1600 2000 FEET
LEGEND
KEWEENAWAN SERIES
Nipissing Diabase
Intrusive Contact
COBALT SERIES
Conglomerate, greywacké, quartzite
Unconformity
KEEWATIN SERIES
Greenstone complex
Shaft
Vein
North Mag.
North Ast.
NIPISSING
CART L.
PETE
N
No1
No2
No1
SENECA SUPERIOR
No2
No3
GOULD
No4
66' ROAD ALLOWANCE
PROVINCIAL
SAVAGE
A
B
C
D
E


O'BRIEN
NIPISSING
TERSON
LAKE
ISLAND SHAFT
NOVA SCOTIA
F
66' ROAD ALLOWANCE
IPISSING
SENECA SHAFT
NIPISSING SHAFT
CART LAKE
WINZE 135'
Section A-B
PETERSON LAKE MAIN SHAFT
PETERSON LAKE
Section C-D
LITTLE SHAFT
ISLAND SHAFT
PETERSON
LAKE
Section E-F



No. 2 "Shaft," Peterson Lake Silver Cobalt Mining Company, Limited.

Seneca-Superior

The Seneca-Superior Silver Mines, Limited, are operating the leases on Peterson and Cart lakes formerly held by the Kerry Mining Company. The company have an authorized capital of 500,000 shares of a par value of $1.00.

The officers of the company are: Mr. S. Harry Worth, president; Mr. F. W. Zoller, vice-president; Mr. R. F. Segsworth, treasurer; Mr. W. E. Segsworth, consulting engineer; Mr. R. H. Lyman, mine manager.

The development during 1913 was as follows:

Drifting on veins	645.4 feet
Drifting on exploration	3,453.5 feet
Sinking and raising	350.6 feet

No. 2 shaft was completed to the 200-foot level and connected on this level with No. 1 shaft. A winze was sunk from the west end of the 200-foot level, near the Gould line, a distance of 145 feet, and levels opened up at 65 and 135 feet from the collar of the winze.

During the year 1,174,000 oz. of silver were produced, and $263,136.20 paid in dividends.

Silver Bar

The Silver Bar mine was operated during the year, under lease, by the Preston East Dome Mining Company, Limited, an average force of ten men being employed.

Drifting and cross-cutting totalled 800 feet; a winze was put down from the 80- to the 120-foot level; the raising amounted to 60 feet.

Mr. Stuart M. Thorne is manager.

Temiskaming

This property, consisting of the south half of the northeast quarter and the west half of the southwest quarter of the north half of lot 1, in the third concession of Coleman, is owned by the Temiskaming Mining Company, which have an authorized capital of 2,500,000 shares of a par value of $1.00. The officers and directors of the company during 1913 were as follows: Mr. Burr E. Cartwright, Buffalo, president; Mr. J. L. Wheeler, Marion, S.C., vice-president; Mr. Alex. Fasken, Toronto, secretary-treasurer; Mr. R. A. Cartwright, Ridgeway, Pa.; Mr. Ernest C. Whitbeck, Rochester, N.Y., and Mr. Wallace Thayer, Buffalo, N.Y., directors; Mr. Norman R. Fisher, Cobalt, general manager.

During the year a working option was taken on the Duchess property, adjoining the Temiskaming on the south, with the intention of continuing the present shaft on this property to the 250-foot level, where extensive exploratory work will be prosecuted.

The main shaft on the Temiskaming is being continued from the 650-foot level to the 750-foot level.

The underground work accomplished during the year is shown in the following table, taken from the company's annual report:

Level	Drifting	Cross cutting	Sinking Winzes	Raising	Sinking Shaft	Total
ft.	ft.	ft.	ft.	ft.	ft.	ft.
90	....	30.0	....	....	....	30.0
200	....	....	....	....	....	....
250	25.6	24.0	....	....	....	49.6
300	242.7	73.9	....	50.0	....	366.6
350	....	....	....	....	....	....
400	83.0	127.3	....	15.0	....	225.3
450	182.1	89.4	....	12.4	....	283.9
500	258.4	104.0	18.0	34.4	....	414.8
575	963.1	164.9	38.0	235.8	....	1,401.8
650	1,044.7	253.5	89.3	117.0	9.1	1,513.6
725	83.7	17.3	....	10.0	....	111.0
Totals....	2,883.3	884.3	145.3	474.6	9.1	4,396.6

During the year the mill treated 32,307 tons of 18½-oz. ore, producing 483,796 oz. of silver, a recovery of 81 per cent. The ratio of concentration was 62 into 1.

The production from high-grade ore was 255,930 oz. of silver; the grade averaged over 4,000 oz. per ton, most of this being produced from the diabase formation.

Trethewey

This property is owned and operated by the Trethewey Silver Cobalt Mine, Limited, which have an authorized capital of 2,000,000 shares of a par value of $1.00, of which 1,000,000 shares have been issued.

The officers of the company are as follows: Mr. Alex. M. Hay, Haileybury, president; Mr. Sidney Small, Toronto, vice-president; Mr. J. L. Pashler, secretary-treasurer; Mr. David Fasken, Toronto, Messrs. W. J. Sheppard, Waubaushene, Jas. B. Tudhope, Orillia, and S. R. Wickett, Toronto, directors; Mr. D. L. H. Forbes, Toronto, consulting engineer; Mr. H. G. Young, Cobalt, manager.

The development during the year amounted to 2,194.5 feet of drifts and cross-cuts; 555.5 feet of winzes and raises; 198 cubic yards of station and grade cutting. The greatest production during the year came from the southwest area, or Nos. 2 and 5 shaft sections.

The mill treated 35,282 tons of ore of an average value of 21.2 oz. at a total cost of $1.46 per ton. The tonnage milled was 32.1 per cent. greater in 1913 than in 1912, and the cost per ton 25.2 per cent. less. The crushing plant was remodelled during the year.

The total production of silver for 1913 amounted to 619,427 oz.; $150,000 was paid in dividends.

A working option was taken on the West Beaver mine in the Port Arthur district.

York-Ontario

The York-Ontario Silver Mines, Limited, operated under lease the King Edward Silver Mines during ten and one-half months of 1913.

Mr. Geo. H. Beebe, of Syracuse, N.Y., is president; Mr. H. E. Jackman, vice-president; Mr. T. S. Shuttleworth, manager.

The drifting and cross-cutting done during the year amounted to about 450 feet, of which 120 feet was done on the 500-foot level. A diamond-drill hole was put down 650 feet from the 500-foot level, and encountered the lower Keewatin contact at a depth of about 1,100 feet. It is the intention of the management to sink to and explore the vicinity of this lower contact.

The King Edward mill was operated under lease by the City of Cobalt Silver Mining Company for the first five months of the year. It was then taken over by the King Edward Silver Mines, and ore from the York-Ontario was treated for about four months.

Elk Lake Area

Beaver Auxiliary

Operations were carried on at this property by Manager H. L. Donaldson, with a force of 25 men, until about the end of the year, when the mine was closed down for the winter on account of lack of water. The main shaft has been continued to a depth of 220 feet, the development at the 200-foot level comprising about 400 feet of drifts and cross-cuts.

The plant consists of two 90-h.p. boilers, an 8-drill compressor, a 6 by 8 hoist, and a 100-light generator for electric lighting. Ample supplies are being taken in for next season's operations.

Cobalt Frontenac

This property, situated in lot 7 of the first concession of Tudhope township, is owned by a Hamilton syndicate, of which Mr. Fletcher is managing director. Mr. C. D. Booth is superintendent.

A plant, comprising a 100-h.p. boiler, a 4-drill compressor, and a hoist, has been installed.

A shaft has been sunk to a depth of 200 feet. Two levels have been driven to intersect some mineralized quartz veins, the cross-cutting on each amounting to 150 and 200 feet, and the drifting on the 200-foot level to about 100 feet.

Fleur de Lis

The Fleur de Lis Silver Mining Company, Limited, have continued operations on the northwest quarter of lot 7 in the first concession of Smythe township. The shaft has been sunk to a depth of 260 feet, and the vein cut at a distance of 20 feet north on the 250-foot level. Drifting was in progress with one drill.

The plant consists of an 18-h.p. boiler and a 6 by 8 hoist.

Mr. E. Bassette is in charge.

Forest City

The Forest City Mines Syndicate operate what are known as the Currie claims at Hubert lake. The shaft has been sunk 100 feet under contract by Mr. G. W. Wheeler. Mr. James Day is in charge.

Mapes-Johnston

The Mapes-Johnston claim, near Silver lake, in the township of Mickle, was being worked with a force of ten men, under the superintendence of Mr. D. G. Oliver. The workings consist of a prospecting shaft 85 feet deep, and a working shaft 100 feet in depth, with 130 feet of drifting at that level.

The Montreal-James plant has been purchased and is being transferred to the property.

Downey

Mr. Larry Downey has been conducting mining operations on his claim near Silver lake with a small force of men. Ten tons of high-grade ore have been taken out from an open cut, and are awaiting shipment when the sleigh roads become good. This will be the first shipment from the Montreal River district since 1910, when the Lucky Godfrey shipped a car of ore.

Moose Horn

The Moose Horn mines were being operated until nearly the end of the year. About 1,000 feet of drifting has been done on the 125-foot level. Two winzes have been sunk to depths of 50 and 75 feet below this level.

Mr. Albert Pardon was in charge.

Paragon

The Paragon Silver Mining Company, Limited, have been engaged sinking a shaft on one of their claims in Willet township. This shaft is 90 feet in depth.

The plant consists of a 50-h.p. boiler; a hoist has been ordered.

Mr. Joseph P. Welsh was in charge, with a force of eight men.

Gowganda

Caleta

The Caleta Silver Mines, Limited, formerly the Calcite Lake Mining Company, were operating their claim in Lawson township with a force of 15 men; operations, however, were suspended early in 1914. The shaft has a depth of 285 feet, the development therefrom consisting of 340 feet of drifts and 310 feet of cross-cuts, mainly at the 200-foot level.

The plant consists of two boilers, with a total of 85-h.p., a 3-drill compressor, and an 8 by 10 hoist.

Mr. John Wilson is captain, and Mr. A. D. McMillan managing director.

Dowling

At the Dowling claim, near Bloom lake, a shaft was being put down from the 45-foot to the 100-foot level. Mr. Donald McRae was the contractor.

Thompson-Gowganda or Gamey-Thompson

At the Thompson-Gowganda claims, northwest of Spawning lake, some drifting was being done by contract, on the adit level, by Mr. Donald McRae.

Hewitt

The Hewitt Lake Mining Syndicate suspended operations on their claims on the west ridge in Nicol township in December, in order to add a compressor to their plant. This plant will then comprise: two boilers with a total capacity of 50-h.p., a 3-drill compressor, and a hoist.

The shaft has a depth of 150 feet, with levels at 50 and 150 feet. Drifts total 180 feet, and cross-cuts 50 feet.

Mr. M. F. Cottrell is manager.

Mann

The Mann Mines have been operating, with a force of 25 men. Early in 1914 the control of the property passed to an English syndicate, and there are prospects of operations being conducted on a larger scale. There are in all five shafts, with depths varying from 40 to 200 feet, and about 3,000 feet of drifts and 740 feet of cross-cuts, inclusive of the Boyd-Gordon workings. Stoping was in progress at the beginning of 1914.

The plant consists of four boilers with a total capacity of 150-h.p., a compressor with a capacity of 580 cubic feet per minute, and four hoists.

Mr. G. R. Rogers is manager.

Miller Lake-O'Brien

Developments have been very satisfactory at this property during the year. The main shaft has reached a depth of 450 feet, and the production is being maintained from the levels down to 350 feet.

The underground force numbers 45 men, and the total employees 145.

The present plant consists of six boilers with a total of 400 h.p., three compressors with a capacity of 2,640 cu. ft., and six hoists.

This report includes the Millerett property as well, on which considerable surface prospecting was done during the past summer. Important discoveries were made on both properties. A new shaft, which is being put down on the ore on the Millerett, has reached a depth of 25 feet.

A new hydro-electric plant, to develop 500 h.p., is being installed on the east branch of the Montreal river at Gowganda townsite. The mine plant is being electrified, and a new motor-driven compressor of 2,000 cu. ft. capacity is being added.

Mr. K. D. Woodworth is manager.

Walsh

The Walsh Mines, Limited, at Miller lake were timbering the first 50 feet of their shaft, preparatory to sinking another 50 feet.

Mr. Robert Gamble is manager.

South Lorrain

Wettlaufer-Lorrain

The Wettlaufer-Lorrain Silver Mines, Limited, authorized capital of 1,500,000 shares of a par value of $1.00 each, operated until October 31st, 1913, when it was decided to cease active work at the property.

The officers of the company are as follows: Mr. Henry Lockhart, Jr., president; Mr. Julius A. Lewisohn, vice-president; Mr. E. H. Westlake, secretary-treasurer; Mr. Robert Livermore, manager.

During the year $141,659 was paid in dividends.

The development during the year was as follows:

Drifts	755 feet
Cross-cuts	357 feet
Raises and winzes	278 feet
	1,390 feet
Surface trenching	127 feet
Diamond-drilling	982 feet
Total	2,499 feet

Porcupine Gold Area

The year 1913 was the most successful in the history of this gold area. On June 9th the miners' strike was allowed to lapse. During the year new mills were completed at the Porcupine Crown, McIntyre and Dome Lake, the Dome mill was increased from 40 to 80 stamps, and the capacity of the Hollinger mill raised from 300 to 500 tons a day. Porcupine Crown was the second Porcupine property to go on a dividend-paying basis. On January 1st, 1914, a dividend of 12 per cent. per annum, payable quarterly, was declared.

The successful results attained by the operating companies have led other companies to invade this field. The McKinley-Darragh Savage Company are developing the Jupiter mine. The General Development Company took an option on the Hollinger Reserve mine. The Temiskaming and Hudson Bay Mining Company financed the Dome Lake. The Huronian Belt Syndicate are developing the North Thompson; the Vipond mine has been reorganized; the Homestake Mines and Finance Company are developing the Foley-O'Brien, Little Pet and Porphyry Hill properties.

Acme Gold Mines, Ltd.

The Acme Gold Mines, Limited, operate the Dixon claims adjoining the Hollinger on the east, being controlled by the Canadian Mining and Finance Company, Limited, of which the officers are: Mr. L. H. Timmins, president; Mr. J. McMartin, vice-president; Mr. D. A. Dunlap, treasurer; Mr. J. B. Holden, secretary; Mr. P. A. Robbins, general manager.

There are four shafts on the property, with depths respectively of 175, 325, 115, and 30 feet. The development work during 1913, which was all done in the latter part of the year, comprises: 134 feet of sinking, 515 feet of drifting, and 613 feet of cross-cutting, or a total of 1,262 feet.

The employees number 71, of which 46 are underground.

The plant consists of one 30-h.p. boiler for heating purposes, a compressor of 1,500 cubic feet capacity, three 10 by 12 hoists, one 8 by 10 hoist, one 6 by 8 hoist, two 500-k.w. transformers, and one 30-h.p. motor.

Mr. H. G. Skavlem is manager.

Dome

The mines operated by the Dome Mines Company, Limited, are situated on the north half of lot 4 in the first concession of Tisdale township. The company have an authorized capital of 500,000 shares, with a par value of $10.00 each. The officers of the company are: Mr. Ambrose Monell, president; Mr. W. W. Mein, consulting engineer; Mr. H. C. Meek, general superintendent.

The results for the year ending March 31st, 1914, are shown in the following summary of development in feet:

80-Stamp Mill at Dome Mine

Total of all development, 100-foot level, shaft No. 1	1,607
Total of all development, 200-foot level, shaft No. 2	49
Total of all development, 3rd level, shaft No. 2	3,098
Total of all development, 4th level, shaft No. 2	744
Total of all development, 5th level, shaft No. 2	1,081
	6,579
Sinking	223
	6,802

Mining operations were as follows:

Total ore from pits	122,965 tons
Total ore from development	17,699 tons
Total ore from stopes	4,782 tons
	145,446 tons
Total ore to mill	145,446 tons
Total waste to dump	18,896 tons
Total tonnage mined	164,342 tons

The following figures show mill operations and results:

Tons milled	145,300
Yield by amalgamation	$731,229 94
Yield by cyanidation	$473,033 80
Total value	$1,204,263 74
Value per ton	8 29
Per cent. value recovered	94.43
Average number of tons treated per day	398

There have been installed three new Farrell jaw crushers, which replace the gyratory crushers formerly in use. One, 36 by 24, replaces the 7½ gyratory crusher, and two, 36 by 10, replace the two No. 3 gyratory crushers.

A new electrically-driven Ottumwa hoist now replaces the old steam hoist formerly used on the incline.

The system of selective stoping, which has been followed underground at the Dome mine in the past, is being superseded by a method by which the whole ore body will be mined, and the production of the mine greatly increased. By this method rib pillars and stopes 40 feet in width are carried right across the ore body. The main haulage way is driven parallel to the long axis of the ore body, and the drifts through which the ore is taken from the stopes are run off at right angles to the main drive.

Mr. W. F. Battersby, mill superintendent, gives the following information regarding additions to the present mill:

The addition to the Dome mill now under way will consist mainly of 40 stamps and six sand-leaching vats. The pulp from the 80 stamps will pass to five duplex Dorr classifiers, the oversize going to five 5 by 22-foot tube mills. The discharge from these tube mills, joined by the overflow from the classifiers, will, after first passing over secondary amalgamation plates, be elevated by bucket elevators to a system of cones, where it will be classified into sands and slimes, the former passing to the six sand-leaching vats, and the latter to four Pachuca agitators now being used in the present mill. From these agitators the slime will be drawn as at present to Merrill slime presses, and the gold-bearing solution precipitated in Merrill precipitating presses. The completed mill is expected to treat 750 tons of ore daily.

New Mill and Shafthouse at Dome Lake Mine

Dome Lake

The control of the Dome Lake Mining and Milling Company passed during the year to the Temiskaming and Hudson Bay Mining Company. Mr. George Taylor is the new president, and the head office has been transferred to New Liskeard, Ontario. The transfer was made in November. Mr. A. H. Brown is the manager, and Mr. G. C. Cochrane is superintendent.

The following is a summary of the work done on the property up to the end of the year 1913:

Sinking—		
"A" shaft, No. 1 vein	60 feet	
"C" shaft, No. 3 vein	193 feet	
"D" shaft, No. 3 vein	135 feet	
Main shaft, No. 3 vein	235 feet	
		623 feet
Winze on 115-foot level, No. 3 vein		42 feet

Drifting—		
60-foot level, No. 1 vein	275 feet	
60-foot level, No. 3 vein	640 feet	
115-foot level, No. 3 vein	1,070 feet	
180-foot level, No. 3 vein	798 feet	
		2,713 feet
Cross-cutting—		
On 60, 115 and 180-foot levels		696 feet
Raising—		
On 60, 115 and 180-foot levels		571 feet
Total footage		4,645 feet

The sinking done during the year comprises the winze, 42 feet, and 123 feet in the two deeper shafts. Of the drifting and cross-cutting, which totals about 4,000 feet, about 2,000 feet was done during 1913.

The ten-stamp mill was operated during May, June and July, and crushed 3,717 tons, from which there was recovered by amalgamation $19,762.00, and by concentration $5,607.00.

Foley-O'Brien

Work has been resumed in the main shaft of the Foley-O'Brien Mines, Limited. This has a depth of 168 feet, and a winze has been sunk from the 160-ft. level to a depth of 90 feet. There are two other shafts on the property with depths of 70 and 100 feet respectively. Drifts and cross-cuts total 900 feet.

The plant consists of two 50-h.p. boilers, two compressors with a capacity of 600 cubic feet, and three hoists.

Mr. H. B. Hatch is manager, employing a force of 20 men.

Hollinger

The holdings of the Hollinger Gold Mines, Limited, consist of four 40-acre claims, comprising the east half of the north half and the northeast quarter of the south half of lot 11, and the northwest quarter of the south half of lot 10, in the second concession of Tisdale.

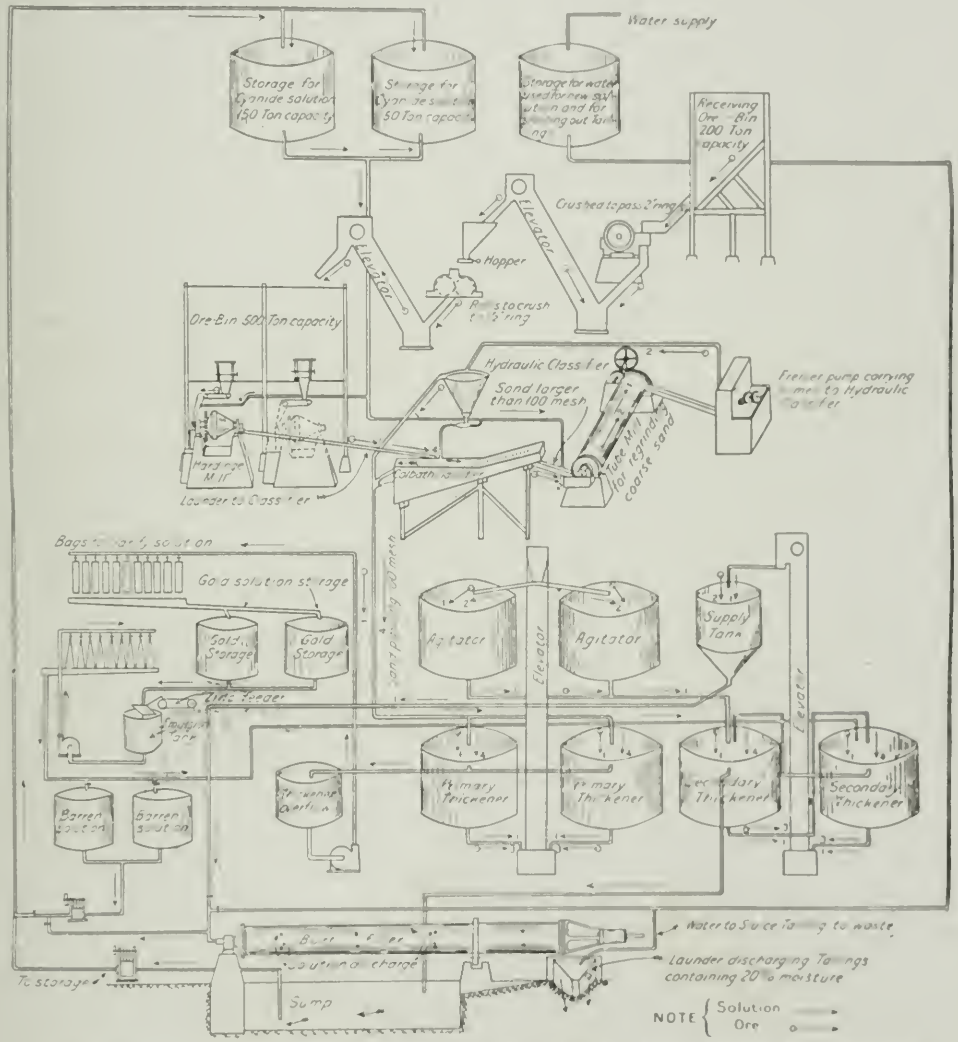
The company have an authorized capital of $3,000,000, divided into 600,000 shares of a par value of $5.00. Mr. Noah Timmins is president; Mr. D. A. Dunlap, secretary-treasurer; and Mr. P. A. Robbins, general manager.

The third annual report of the company shows that during 1913, 138,291 tons of ore were treated, yielding $2,466,220.24, that $1,170,000 were paid in dividends, and that the ore reserves were increased by $3,000,000.

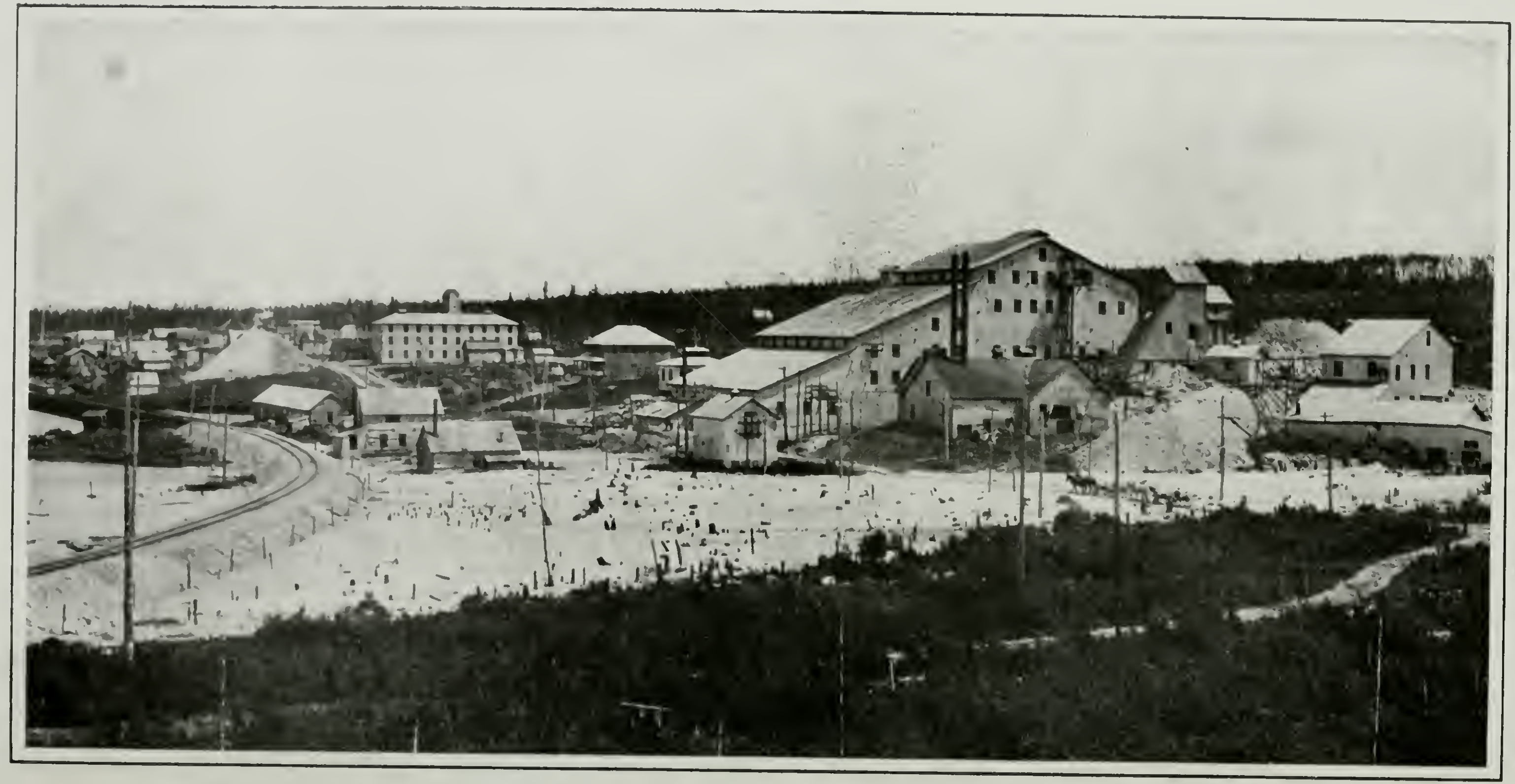
During the year the following work was accomplished:—

——	Drifts	Crosscuts	Raises	Winzes	Shafts	Diamond Drilling	Trenches
	ft.	ft.	ft.	ft.	ft.	ft.	ft.
Surface		8			253	601	550
100 ft. level	1,031	250				784	
200 ft. level	1,524	240	323			790	
300 ft. level	1,351	238		130	115	383	
425 ft. level	243	212	11	82		93	
Totals	4,149	948	334	212	368	2,651	550

During the year $46,832 was expended upon bunk houses and dwellings. The former consist of plastered rooms, two single beds in a room; they are supplied with steam heat, electric light, and modern sanitary arrangements.



Flow Sheet of McIntyre-Porcupine Mill. Numbers Before Arrows Denote Relative Solution to Ore



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McIntyre-Porcupine Gold Mine

Hollinger Reserve

Active development work has been carried on at the property of the Hollinger Reserve Mining Company in Ogden township during 1913, consisting of the following: cross-cutting, 210 feet on the 100-ft. level, and 187 feet on the 200-ft.; drifting 150 feet on the 100-ft. level, and 1,200 feet on the 200-ft.; a winze sunk 118 feet from the 200-ft. level; 300 feet of drifting on the 300-ft. level.

During the year the property was taken over under option by interests allied to the Kerr Lake Mining Company.

Mr. H. W. Evans is manager, employing 40 men.

McIntyre

The McIntyre Porcupine Mines, Limited, during 1913 carried out an extensive plan of development and construction work on their holdings at the west end of Pearl lake. The directors and officers of the company are: Mr. Albert Freeman, New York, president; Mr. C. B. Flynn, New York, vice-president; Mr. M. P. van der Voort, Toronto, secretary-treasurer; Mr. J. P. Bickell, Toronto; Mr. H. L. Kramer, Toronto; Mr. I. J. R. Muurling, New York; Mr. R. J. Ennis, general manager.

Development work during the year consisted of 204 feet of shaft-sinking, and 3,967 feet of drifts, cross-cuts, raises and winzes; 37,667 tons of ore were mined.

The new 150-ton cyanide mill was put in operation in March and up to the end of the year treated 25,335 tons of ore. The stamp mill was used for sampling purposes during the year and treated 5,632 tons of ore. A second unit of 150 tons capacity is being added to the cyanide mill and will be in operation about September 1st, 1914. In the new unit decantation will replace the filters of the old unit.

During the year $232,824.99 in bullion was shipped, and $99,661.33 was spent in buildings and plant.

Miracle

The Porcupine Miracle Mining Company, Limited, are owners of a group of claims in Langmuir township, near the southern end of Night Hawk lake. A working shaft has been sunk to a depth of 100 feet.

The plant consists of two boilers of 40- and 20-h.p., a 12-drill compressor, a small hoist, and a small portable saw mill.

A 100-h.p. boiler, two jaw crushers, and a 60-ton Hardinge ball mill are to be taken in during the winter.

Mr. H. B. Ransome is manager, employing 20 men.

North Dome

The North Dome Mining Company, Limited, controlled by the Temiskaming Mining Company, ceased operations on their property on lots 3 and 4 in the first concession of Tisdale. Regarding the results of the underground development the management state that a large tonnage of low-grade ore, running between $6 and $7 to the ton, was indicated, and that a diamond-drill hole, put down in the previously unprospected ground near the southwest corner of the property, where the contact between the slate and prophyry is hidden from view by deep muskeg, encountered at a vertical depth of 400 feet about 60 feet of quartz, which, although giving a low average assay, showed in the core free gold easily visible to the naked eye.

North Thompson

Towards the end of the year an option was taken on this property, which lies between the Porcupine Crown and the Vipond mines, by the Associated Gold Mines of West Australia. A prospecting shaft is being sunk, and several diamond drills are at work on the property.

Mr. N. J. Evered is manager.

Pearl Lake

The following is the development footage accomplished on this mine up to the end of December, 1913: Drifting, 1,166.18 feet; cross-cutting, 1,649.89 feet; raising, 168 feet; depth of main shaft, 673 feet.

Porcupine Crown

The Porcupine Crown Mines, Limited, took over the McEnaney claim, which adjoins the Hollinger on the south, on June 10th, 1913. The McEnaney claim was developed by the Crown Reserve Mining Company, which company received 1,667,000 shares of the 2,000,000 shares of the Porcupine Crown Mines, Limited.

The officers of the company are as follows:—Lieut.-Col. John Carson, president; Mr. J. W. Gear, first vice-president; Mr. C. E. Potter, second vice-president; Mr. James Cooper, secretary and treasurer; Mr. John Reid, assistant secretary-treasurer; Mr. S. W. Cohen, general manager; Mr. M. W. Summerhayes, resident manager.

The Porcupine Crown Mines, Limited, was the second Porcupine mining company to go on a regular dividend-paying basis. On January 1st, 1914, the company began paying a dividend of twelve per cent. per annum, payable quarterly.

The development work during 1913 was as follows:—

	To 1913.	1913.	Total.
	ft.	ft.	ft.
Sinking and raising	738	554	1,292
Drifting	1,402	702	2,104
Cross-cutting	1,301	1,225	2,526
Total	3,441	2,481	5,922

Stoping in cubic feet	142,643
Cubic feet—Sump	2,734

In addition 2,739 feet of diamond-drilling was done. The main shaft is now down to the 400-ft. level, and a winze has been sunk from the 400 to the 500-ft. level.

During the year the following buildings were erected:—

Mill and refinery, bunk house, dry house, oil house, pipe shop, carpenter's shop, powder magazine, six small cottages for married employees, main shaft house and tramway, additions to power house for installation of a new boiler, transformer house for the installation of three new 50 k.w. transformers, addition to the cook camp. A new 15-drill compressor was installed in the power house, also a new motor for large electric hoist. The machine shop was fully equipped, and a drill sharpener was added to blacksmith's shop.

The mill was increased by the addition of 15 stamps, duplex classifier, tube mill, cyanide tanks, etc. The continuous decantation process of cyaniding the ore is used. The maximum capacity of the mill is 180 tons per day; an extraction of 96 per cent. is being made. During the year 19,754 tons, of an average value of $20.30 per ton, were treated.

Porcupine Lake

The Porcupine Lake Gold Mines, Limited, have continued their shaft on the shore of the lake to a depth of 275 feet on the incline, and have cut a station at that level.

The plant consists of one 60-h.p. boiler, a 4-drill compressor, and a hoist. A 15-drill electrically-driven compressor, a 55-h.p. motor, and the necessary transformers are on the ground ready to be installed.

Mr. J. F. Wenstrom is manager, employing 20 men.

Rea

The Mines Leasing and Development Company acquired a lease on the Rea mine in May, 1913. The property was taken over by the leasing company in May, 1914, and the Porcupine Aurum Mines Company, Limited, formed.

A 10-stamp mill is in operation.

Mr. David Sloan is manager, employing 40 men.

Porcupine Lake Gold Mine

Schumacher

Schumacher Gold Mines, Limited, started work on the Schumacher property south of Pearl lake in June.

The south cross-cut on the 100-ft. level of No. 2 shaft was continued 140 feet, where No. 2 vein was cut; 200 feet of drifting was done on this vein.

From these workings a 3-compartment shaft, 6 by 15 feet, was raised to the surface; a head frame was erected and a power plant installed. Sinking was then begun in this shaft and it had reached a depth of 175 feet at the end of the year.

The amount of drifting and cross-cutting done from June 4th to the end of the year was 705 feet; raising, other than main shaft, 18 feet. There were also 2,500 cubic feet of stations and sumps cut.

The plant consists of one 135-h.p. Jenckes boiler, one 10 by 12 double-drum Jenckes hoist, one 540 cubic-foot cross compound Ingersoll-Rand compressor, one 100-h.p. C. G. E. motor, two 50-K. V. R. transformers, and one 6 by 8 single-drum Jenckes hoist.

Three Nations

The Three Nations Gold Mining Company, Limited, in Whitney township have sunk a shaft to a depth of 225 feet. The drifting on both levels amounts to about 800 feet, and the cross-cutting to 700 feet.

The plant consists of three 100-h.p. and one 35-h.p. boilers, a 3-drill compressor, and an 8 by 10 hoist. A 10-stamp mill has been built on the property.

Mr. J. N. Angrignon is manager, employing 40 men.

Surface Plant at Schumacher Mine

Surface Plant of Three Nations Mine

Alexo Nickel Mine

The Alexo Mines, Limited, on lot 1 in the third concession of Dundonald township, are mining nickeliferous pyrrhotite of a very good grade and shipping it to the Mond smelter at Coniston. The ore is teamed three-quarters of a mile and then loaded in cars on the T. & N. O. railway siding at Kilburn. The ore has been taken from a pit 75 feet deep and 60 feet long on an ore body averaging about 15 feet in width, and from a drift run 70 feet to the south from the bottom of the open pit. Drilling was done at first with hand steel, but later a 30-h.p. boiler was put in, which is used to run one drill and the hoist.

The property was located at the time of the building of the National Transcontinental railway, and before the discoveries at Porcupine, by Mr. Alex. Kelso, who was guided to the place by the attraction of the magnetic needle noted in the land surveyor's reports. It is worked by a syndicate, composed of the original owners headed by Mr. E. F. Pullen, who acts as manager. Fourteen men are employed.

Dane and Larder Lake Areas

Goldfields

The 30-stamp mill on this property was running until May, 1913, when work was suspended. The workings consist of an open pit, or glory hole, connecting with an adit level at 65 feet; considerable drifting on this level; and a shaft sunk 125 feet below the 65-foot level.

Besides the mill, the plant consists of an 8-drill compressor, two hoists, and a 25-h.p. boiler for heating purposes. Power is supplied by the company's hydro-electric plant of 750-h.p. capacity at Raven falls, thirteen miles distant. The compressor is driven by a 150-h.p. motor, and the stamps and crushers by motors of 60- and 50-h.p. respectively.

At the end of the year a contract for sinking another 100 feet was let to Mr. Hugh McMillan, of Cobalt. The company are operating 10 stamps to treat the ore obtained in sinking.

Mr. Geo. A. McKay, of Toronto, is manager, and Mr. J. F. Thornham is superintending operations.

Lucky Cross Mill

La Mine D'or Huronia

La Mine D'Or Huronia, Limited, operated by a Three Rivers (Que.) Company, is situated in the fifth concession of Gauthier and McVittie townships.

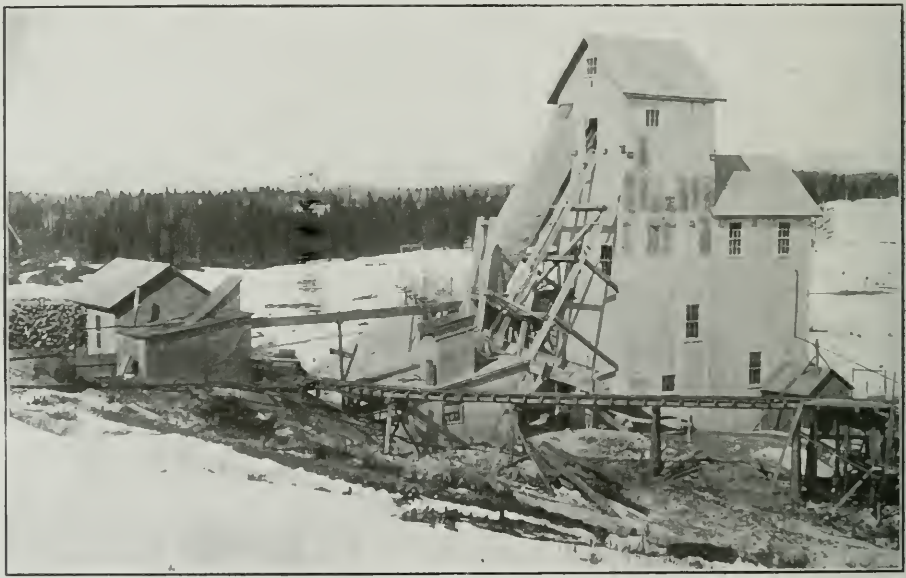
The present 10-stamp mill is being enlarged by the addition of five stamps and a ball mill, two 100-h.p. motors and one 30-h.p. motor, and three 75 K.V.A. transformers. Power will be supplied for the mill, the 7-drill compressor, and the hoist, by their own hydro-electric plant on Victoria creek, three-quarters of a mile distant, which is expected to develop 250 horse-power. The present 35-h.p. boiler will then be used for heating.

The underground workings consist of No. 2 cut, which is down 32 feet, and a short adit at the level of the lake.

Mr. E. H. York is manager, employing 40 men.

Swastika and Kirkland Lake Areas

The Swastika and the Lucky Cross mines both suspended operations during the year.



Shafthouse at Tough-Oakes Mine

Tough-Oakes

The Tough-Oakes Gold Mines, Limited, at Kirkland lake, which were controlled by Mr. C. A. Foster, of Haileybury, sold out during the year to an English company, the Kirkland Lake Proprietary. This company employ 110 men.

The incline shaft on No. 2 vein was continued to a depth of 210 feet, and levels opened at 100 and 200 feet. The drifting on the first level amounts to some 270 feet, and on the second level to half this amount. It is the intention of the management to have this shaft down another 100 feet, and the shaft on the No. 3 vein opened to the first level by the time power is available in the spring.

The present plant consists of a 5-stamp mill, two compressors of 140 and 200 cubic feet capacity, two 6 by 8 hoists, four boilers with a total capacity of 125-h.p., and a D.C. generator for electric lighting. The additions to the plant comprise a 250-h.p. motor, a compressor of 1,526 cubic feet capacity, a 10 by 12 hoist, and a skip of 25 cubic feet capacity. Power will be supplied by the Charlton and Englehart Power Company from their plant at Charlton.

Mr. C. A. O'Connell, manager, gives the following table of production and shipments during the years 1912 and 1913:

Shipment	Date	Net Dry tons	Oz. per ton Silver	Oz. per ton Gold	Gross Value
A	Sept. 8, 1912	1.892	....	17.451	$ 660 37
B	Dec. 21, 1912	19.905	23.400	22.509	9,235 60
C	Mar. 19, 1913	20.527	33.665	19.688	8,492 23
D	June 5, 1913	30.438	37.900	23.040	13,147 10
E	Oct. 31, 1913	28.287	67.500	24.075	14,685 90
	Total	101.049	....	....	$46,221 20

The bullion won from 1,975 tons milled in 1913 was as follows:

Bullion Bar	Date	Oz. Silver	Value Silver	Oz. Gold	Value Gold	Gross Value
			$		$	$
1 2	June, 1913	50.83	29 54	296.175	6,122 48	6,152 02
3	Aug. “	28.10	16 50	207.250	4,212 75	4,229 25
4a	Sept. “	43.86	26 53	280.321	5,794 75	5,821 28
5a	Nov. “	37.84	22 42	233.662	4,830 23	4,852 65
6a	Dec. “	37.60	21 57	255.038	5,272 10	5,293 67
	Total	198.23	116 56	1,272.446	26,232 31	26,348 87

Wright-Hargraves

Work on the Wright-Hargraves claims was suspended about the end of the year by the Cartwright interests, who held them under option.

This property comprises four claims in the township of Teck at the east end of Kirkland lake.

The development work consists of two shafts, 20 and 85 feet in depth, and 110 feet of drifting on the 75-foot level.

Teck-Hughes Gold Mine, No. 1 Shaft

Teck-Hughes

The Teck-Hughes Gold Mines, Limited, prosecuted development work actively during the year. They have four shafts in all, varying in depth from 40 to 212 feet. No. 1 shaft is down 212 feet, and the drifts on the 200-foot level total 203 feet. Work has been discontinued in this shaft. No. 2 shaft has been put down in the southwest corner of the property to a depth of 75 feet. Drifting was commenced on the 75-foot level in the shaft early in December, and is being carried on at the rate of about 125 feet a month. Some good ore shoots have been encountered.

The plant consists of two boilers of 60 h.p., a 2-drill compressor, and a hoist.

Mr. Alex. H. Smith is consulting engineer and manager.

Sylvanite

The Sylvanite Gold Mines, Limited, formerly the Wright and Robbins claims, adjoining the Tough-Oakes on the west, have also been acquired by the Kirkland Lake Proprietary.

Dining-room and sleeping camp have been built, and a force of 15 to 18 men were engaged during the winter in trenching. There are two prospecting shafts down to depth of 50 and 40 feet.

Mr. C. A. O'Connell is manager.

Burnside

The Burnside Gold Mines, Limited, whose claims adjoin the Tough-Oakes on the south in the townships of Teck and Lebel, are also controlled by the Kirkland Lake Proprietary and are under the same management.

The only work done on the Burnside claims during the winter consisted of 500 feet of diamond-drilling on the southwest corner of L. 1821. There are two shafts, with depths of 70 and 90 feet respectively; on the 75-foot level 190 feet of cross-cutting and drifting has been done.

The plant consists of two boilers, a compressor of 175 cubic feet capacity, and a small hoist.

Solid Silver

The Solid Silver Mines, Limited, are situated in Burt township, about 13 miles west of Kenogami Station, on the Temiskaming and Northern Ontario railway. They are reached by a wagon road six miles long from Kenogami lake. The first seven miles of the journey is made by boat. The workings consist of a shaft 100 feet deep and 75 feet of cross-cutting on the 100-foot level. The plant comprises a 60-h.p. boiler, a 6 by 8 hoist, and a portable sawmill. The mine was in operation during a portion of the year. Mr. Wm. Shovel is superintendent, and Col. Daniel B. Shepp, president.

IV.—EASTERN ONTARIO

During 1913 Eastern Ontario continued to attract considerable attention from mining men. Possessing as it does a variety of minerals, some of which occur in large bodies of commercial importance, interest is continually sustained, and prospecting in a desultory manner is carried on almost continuously throughout the year. Occasionally new and important discoveries of mica are made, and in the non-metallics alone Eastern Ontario presents a practically virgin field for systematic, scientific prospecting.

During the year gold, talc, amber mica, magnetic iron ore, apatite, graphite, iron pyrites, feldspar, quartz, corundum and fluorite were mined and shipped.

Attention was attracted some years ago to the sodalite deposits near Bancroft in Hastings county, and a small quantity was shipped for decorative purposes, but the deposits were not found to be of commercial importance. The universal agitation throughout the Province for better roads, and the gradual awakening of the boards of trade and business men in general, to the fact that good roads are of first importance in the development of trade, have drawn attention to Eastern Ontario as a source of supply for road-making material. Trap rock or diabase, considered the most durable for macadamized roads, is found in Peterborough and Hastings counties. At Preneveau, near Havelock, a large quarry is being operated by the Ontario Rock Company. In Frontenac and Hastings counties unlimited supplies of limestone and granite are to be found.

This area has also shared in the recent development of the brick industry and its allied clay products.

Frontenac county continues to be the leading producer of feldspar. The Richardson mine in Bedford township showed an increase over 1912, and the Reynolds mine owned by the same company is proving to be a large deposit of high-grade spar.

Formerly all of the spar produced was shipped to the New Jersey and Ohio potteries, in tne raw state, or as ground spar from the Genesee grinding plant near Charlotte, New York. During 1913 the Kingston Floor and Wall Tile Company was formed and a plant built in Kingston. This plant is now producing floor tile, and later on will be manufacturing the larger patterns of wall tile. It will use a considerable quantity of the local feldspar.

Plant of Frontenac Floor and Wall Tile Company, Kingston

Iron

Belmont

Operations at this mine, formerly known as the Ledyard, were continued during 1913 by the Buffalo Union Furnace Company. The mine is situated on the west half of lot 19, first concession of Belmont township, Peterborough county. The 3-compartment vertical shaft has been carried to a depth of 260 feet, and sinking operations were being continued on the date of inspection. The first and second levels remain the same as last report. On the third level, at 235 feet, the south drift had been extended to 125 feet and 55 feet of cross-cutting done.

The ore body appears to be widening at depth, and the grade rising. A branch line of the Central Ontario railway connects the mine with the main line at a point north of Canadian Pacific Railway Junction. The output is being shipped to the new furnace plant of the company at Port Colborne.

Mr. Frank Platto is manager of the mine, employing fifty men.

The Canada Iron Mines, Limited, own the Bessemer and Childs group of mines near L'Amable station, the Coe Hill mines at Coe Hill, and the Blairton mines near Marmora. This company have also built a concentrating plant at Trenton, to which all their ore is shipped via Central Ontario railway.

The Bessemer and Childs group comprise 3,100 acres in the townships of Mayo and Dungannon, and are connected with the main line of the Central Ontario railway by the Bessemer and Barry's Bay railway, owned and operated by the mining company. Mr. W. J. McLaughlin, Trenton, is manager of the company.

Bessemer Mine

At this mine work throughout the year has been confined to development in No. 4 shaft, with stoping continued on the second level.

The first and second level drifts under Little Mullet lake have been carried to the limit and abandoned. At the fourth or 250-foot level a station was cut, and at the date of inspection the management intended to drift in the hanging to a distance of 25 feet from the shaft and at that point sink a winze to the fifth level. The ore is hoisted in a one-ton skip and is dumped directly into a No. 6 Gates gyratory crusher. A 22-inch belt, 44 feet in length, conveys the ore from the crusher to the loading bins. It was proposed to instal a magnetic cobber at the head of the belt conveyor to reject clean rock, heretofore hand picked.

The mine is in charge of Capt. Alfred Hendra, employing 100 men.

Childs Mine

This mine is situated about three miles northeast of the Bessemer, on lot 11 in the ninth concession of the township of Mayo. The ore body has been diamond-drilled to a depth of 300 feet.

At the date of inspection, mining by the open-pit method was being carried on at No. 1 and No. 2 pits, about 300 feet apart. The ore was loaded by hand into wooden, end-dump, train cars of the coal-mine type, capacity 2½ tons each, and 36-inch gauge. The loaded cars are assembled and hauled to the foot of the incline by a 12½-ton dinkey locomotive, hoisted and discharged direct into a No. 5 (K) Allis-Chalmers gyratory crusher, thence to loading bins.

Thirty men are employed.

Rankin-Coe Mine

This prospect is situated on lot 10 in the ninth concession of the township of Mayo, and was worked under lease with option to purchase by the Canada Iron Mines, Limited. The ore body was stripped over an area 300 feet by 75 feet. The option expired on January 1st, 1913, and work was abandoned by the company.

Concentrating Plant

This plant is situated in the town of Trenton, on the east side of the Trent river at the point where it empties into the bay of Quinte. Its situation assures good shipping facilities by lake and rail.

The ore, crushed at the mine to 2½ inch, is received in standard-gauge ore cars and dumped into bins. From the bins it is drawn off by 3 roll-type feeders, and elevated to a shaking screen at the top of the mill. This screen has ¾-inch square openings.

The oversize from the screen goes to the mill bins, and passes through an oscillating feeder to a set of 40-inch by 15-inch Anaconda rolls. The entire crushed and fine product is discharged into a trommel 12 feet in length by 4 feet in diameter, making four sizes and oversize. The fines go direct to the magnetic separator and the coarse sizes to Ball-Norton drum separators. The middlings are recrushed and returned to the separator.

Up to February, 1914, only one unit of the concentrator was in operation on a mixture of Bessemer and Childs ores, the fines being treated by the wet method on a Grondal machine. It was found that better results could be obtained by treating the Childs ore in a separate unit, and for this reason a second unit will be installed in a short time. Each unit will have a capacity of 300 tons of concentrates per day. All the crude ore through the $\frac{3}{4}$-inch screen will be passed through a drier and practically freed from moisture. The coarse sizes will be treated on single-drum Ball-Norton magnetic separators, the fines going to a Ball-Norton belt type machine. Power is purchased from the Trenton Electric Company.

Orton

No work was done at this mine during 1913. Ore for experimental purposes was shipped to Belleville and Deseronto, from stock produced in 1912. The mine is owned by J. W. Evans and associates.

Gold

Cordova Mine

During the first half of the year this mine was worked by P. Kirkegaard and associates. For the first three months 60 men were employed, but the force was gradually reduced and the plant closed down in August.

Stoping was continued on the fourth and fifth levels of No. 3 shaft, and No. 1 shaft was dewatered to the second level. This shaft was square set to the first level and a skip track was put in, on the west side. Considerable broken ore was found in the stopes at the first level, and stoping commenced in the east drift on the second level. Sufficient ore was raised to keep 30 stamps dropping, and it is the intention of the management to connect No. 1 and No. 3 shafts at the 500-foot level.

Golden Fleece

This mine, situated on the west half of lot 24 and lot 25 in the sixth concession of the township of Kaladar, is owned by the Adelaide Mining Company of Baltimore, Maryland, and is operated under lease with option to purchase by the A. B. P. Mining Company, Limited.

On the date of inspection 15 men were employed. Underground development consists of a shaft 85 feet in depth, with a drift at the 65-ft. level running 75 feet to the north, and 45 feet of cross-cutting. This shaft had been abandoned and work was confined to an open cut about 75 feet south of the mill.

The plant consists of two boilers, one 60-h.p. and one 50-h.p., a straight line air compressor with a capacity of 300 cubic feet, two hoists, and a 25-h.p. mill engine.

A 10-stamp mill was operated intermittently, and during the summer the plant closed down.

The officers of the company are:—Mr. A. B. Potter, president, Flinton, Ont.; Mr. J. L. Potter, treasurer, Flinton, Ont.; Mr. E. V. McMillan, secretary, Toronto.

Ore Chimney

The Ore Chimney Mining Company own lots 34, 35 and 36 in the first concession of the township of Barrie. The mine was inspected on December 17th, 1913, and on that date all work was being carried on by Caldwell Bros., contractors. This firm had a contract to sink the shaft to the 375-ft. level and drift 1,000 feet. Work was being carried on vigorously.

On the date of inspection the shaft had been carried to a depth of 160 feet, where the second level station was being cut. The shaft was timbered to the bottom with 8 by 8-inch posts and plates and 6 by 8-inch dividers.

During the summer a new frame boarding-house and storeroom, also a new dry house, had been constructed. The plant remained the same as last report, with addition of a new 100-h.p. boiler and a 12 by 15-inch hoist.

No ore had been shipped from the property.

The officers of the company are:—Mr. A. E. Fletcher, president, Hamilton; Mr. Chas. Narraway, secretary, Hamilton.

Iron Pyrites

Sulphide

The Nichols Chemical Company continued to operate their pyrites mine on lot 23, in the eleventh and twelfth concessions of the township of Hungerford. The company also purchased ore from operators in other parts of the county.

Practically no new work was done in the mine. Stoping was continued on the first and second levels on the north vein, the ore being trammed from the fourth level.

No. 1 shaft, 300 feet in depth, has been abandoned.

No. 2 shaft has been carried to a depth of 575 feet, with six levels. The electric thawing apparatus, installed in an abandoned drift on the fourth level, has given good satisfaction, and is considered a safe and practical device.

In the crusher plant a 36 by 16-inch Allis-Chalmers crusher was installed to follow the No. 3 McCully, replacing the set of 24 by 14-inch rolls now used to finish the product.

A new drier, 40 feet in length by 5 feet in diameter, has been installed in the crushing plant.

The dust in the crushing plant has been materially reduced by the No. 5 American blower fan, capacity 2,040 cubic feet per minute, installed in April, 1913.

No change was made in the acid plant during the year.

Mr. W. H. DuBlois is in charge of the works, employing 130 men.

Queensboro

The Canadian Sulphur Ore Company mine, on the north half of lot 9, in the ninth concession of Madoc township, has been in continuous operation during the year.

The Bay of Quinte railway branch to the mine was completed.

Shafts Nos. 1 and 2 were abandoned and work confined to No. 3, which has been sunk to a depth of 150 feet. The west drift on the first level was extended, and a raise put through to No. 3 open pit. A drift is being run to connect No. 3 and No. 4 open pits.

The shaft has been fitted with guides and a cage installed, and at the time of inspection preparations were under way to instal a new electric hoist to replace the small air-driven hoist then in use.

Mr. W. Coleman is superintendent, employing 50 men.

The officers of the company are:—Mr. A. Longwell, president; Mr. Geo. H. Gillespie, vice-president; Mr. A. B. Willmott, manager.

Craig

Operations were resumed at this mine during the spring of 1913, by the Sulphide Chemical Company of Toronto. The mine is situated in the eleventh concession of the township of Hungerford, near the village of Sulphide.

A new head frame and ore pockets were constructed, and the mine dewatered and sampled. The shaft has a depth of 250 feet, with the first level at 90 feet and the second level at 180 feet. A considerable quantity of ore was found in the first level west stope, and this was hoisted and shipped. A raise was run from the second level east stope to surface.

Mr. Richard O'Connor was superintendent, employing 15 men. Work was discontinued in November, 1913.

Talc

Henderson

This mine is situated on lot 14, in the fourteenth concession of Huntington township, near the village of Madoc. It is operated under lease by Messrs. Cross and Wellington. Practically all the output is delivered direct to the grinding plant of Messrs. Geo. H. Gillespie and Company.

Owing to the fall of ground in March, 1913, No. 2 shaft was abandoned, and work during the year was confined to No. 1 shaft. The caved ground near No. 2 shaft was stripped and worked as an open pit, a large quantity of ore being recovered in this manner No. 1 shaft is now 250 feet deep, and preparations are being made to work the mine on the caving system.

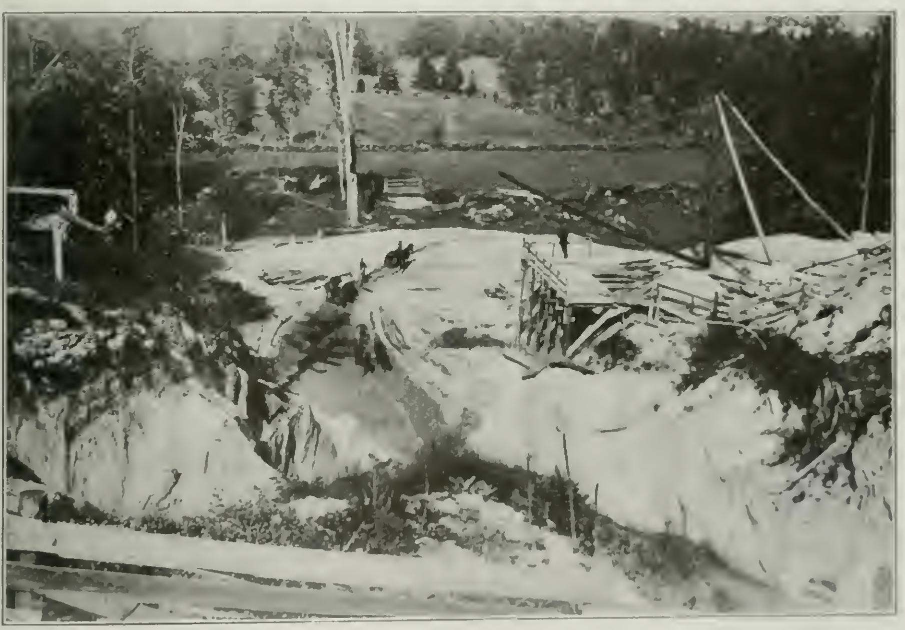
A new compressor, 2-drill capacity, was installed in December, 1913. Mr. Steven Wellington is in charge, employing 25 men.

Gillespie Mill

The talc grinding plant, owned by Messrs. Geo. H. Gillespie and Company, built near the Grand Trunk railway station at Madoc, was operated continuously during the year 1913. Two tube mills were added to the plant and the bag house remodelled during the summer.

Seymour electric power at 220 volts is used to operate the machinery. The crude talc is purchased from Messrs. Cross and Wellington, and hauled by teams from the mine to the mill.

Mr. George H. Gillespie is manager, employing 20 men.



Henderson Talc Mine, Madoc, Ont.

Canadian Talc and Silica Company

The mine and grinding plant of this company are situated near Eldorado station on the Central Ontario railway.

Two incline shafts have been sunk. Stoping was continued on the first level of No. 1 shaft, which at date of inspection was 90 feet deep.

No. 2 shaft was 130 feet deep and connected at the 90-foot level with No. 1 shaft by a drift 200 feet in length.

The mill is equipped with a complete plant for grinding and bolting talc.

Mr. R. M. Phillips is in charge of the property, employing 25 men.

The officers of the Company are:—Mr. H. B. Hungerford, president, Chicago; Mr. David Plant, vice-president and secretary, do.; Mr. M. H. Orde, treasurer, do. Head office, Room 100, McKinnon Building, Toronto.

Connolly

This mine adjoins the Henderson mine to the east, and is owned by the Hungerford syndicate.

A 2-compartment vertical shaft was sunk to a depth of 70 feet, and 75 feet of drifting done on this level. At the date of inspection, Mr. L. J. Browning was in charge, and preparations were being made to instal a complete plant, electrically driven, power to be purchased from the Seymour company. Work was discontinued in the spring of 1913.

Talc Grinding Mill at Madoc

Lead

Frontenac

This mine, situated in the township of Loughboro, near Perth Road, and owned by the North American Smelting Company, Kingston, was closed most of the year, while alterations and experiments were being carried on in the concentrating plant. Shafts Nos. 1 and 2 were not dewatered. At No. 3 shaft the raise in the north drift was pushed through to surface.

The plant at the mine remains as last reported. In the mill, the shaking screens were replaced by trommels, and the jig capacity enlarged.

Mr. C. E. Schwartz was in charge of the mine, employing 40 men.

North American Smelter

The North American Smelting Company operated their lead smelter at Kingston up to November 1st, 1913. Some concentrates from their mine at Perth Road were smelted, but most of the ore treated was purchased in British Columbia.

The blast furnace was rebuilt and new hoods installed on the open hearths, and other changes made to reduce the danger to employees from lead poisoning.

Mr. W. M. Weigel, Kingston, was manager of the company during 1913.

Buffalo and Ontario Smelter

The Buffalo and Ontario Smelting and Refining Company continued operations during the year.

The officers of the company are:—Mr. George Wager, president, Buffalo, N.Y.; Mr. J. J. Gilchrist, superintendent, Kingston; Mr. Geo. H. Fullerton, treasurer, Kingston.

Work during the year was confined to carrying on experiments in the smelting and refining of low-grade silver, cobalt ores, up to the point of making the mixed oxides. The year's work has been confined to experimentation. A few small shipments of cobalt-nickel speiss and mixed oxides were made.

The material for experiments consisted of Nipissing residues, and a small quantity of high-grade cobalt vein matter.

Feldspar

Richardson

As anticipated in last year's report, the output of this mine was considerably increased in 1913. An incline skip track was built and a cobbing house erected, doing away with the old method of hand sorting in the pit.

Stripping to uncover new ground between the old pit and Desert lake was commenced in the fall of 1913, and abandoned when the overburden was found to be of considerable depth.

Fifty men are employed, under foreman S. Hunter.

Mr. H. W. Richardson, Kingston, is president and general manager of the Kingston Feldspar and Mining Company, which owns the Richardson and Reynolds mines.

Reynolds

The Reynolds mine, situated on lot 1, in the thirteenth concession of Portland township, was operated during the year 1913, and several thousand tons of high-grade spar were mined. During the open winter of 1912 and 1913 no ore was shipped. In 1913 the lakes were frozen over early in the season, and the stock pile was hauled to Verona and shipped in box cars to the Ohio potteries. It is anticipated by the management that this mine will have a greater production in 1914, owing to operations on a larger scale being started in the spring.

Mica

With the exception of two mines, the production of mica in Eastern Ontario continues to come from small prospects worked only at intervals. A good market prevailed during 1913 for all sizes and for the different varieties. Interest revived during the year, and considerable prospecting was done in Bedford, Loughborough and Burgess townships.

Lacey

During 1913 this mine, situated on lot 11, in the seventh concession of Loughboro, sustained its previous record as the largest producer of mica in the Province. It is owned and operated by the Loughboro Mining Company.

The main shaft is 185 feet deep, work during the summer months being confined to the open cut near the main shaft.

Mr. George W. McNaughton is manager, employing 30 men.

Taggart

This mine, owned by Messrc. Kent Bros. and Mr. J. M. Stoness, of Kingston, is situated on the west shore of Bob's lake on lot 30 in the sixth concession of Bedford township. It was discovered in 1898 by Thomas Taggart, who opened several shallow pits. The present owners purchased the property in 1903, and since then it has been a steady producer. The mica occurs in a series of parallel veins about 15 feet apart, and having an average width of 3 feet.

The open pits are carried about 8 feet in width.

No. 1 or Taggart pit measures 60 feet in length by 55 feet deep.

No. 2 or King pit measures 50 feet in length by 70 feet deep.

No. 3 or Klondike pit measures 60 feet in length by 60 feet deep.

The mica produced is shipped to Messrs. Kent Bros.' trimming works at Kingston.

Scott

In the summer of 1913 Messrs. Scott Bros., of Bedford Mills, discovered mica on lot 7 in the ninth concession of Bedford township, about one-half mile from the west end of Devil lake on the south shore. The prospect opened up well and in December, 1913, it was sold to Messrs. Stoness, Anglin and Gilbert, of Kingston, who have erected on the property a blacksmith shop, boarding camp and mica house. On the date of inspection preparations were being made to instal a steam plant.

Tett Bros.

This mine is situated on lot 4 in the tenth concession, Bedford township, and was formerly a large and steady producer of high-grade mica. During 1913 it was operated under lease by Messrs. S. C. and W. E. Ennis, of Kingston. Work was confined to prospecting the property for new veins.

Trimming Works

The following firms are engaged in trimming and thin-splitting mica in Ottawa: General Electric Company, Laurentide Mica Company, Messrs. Eugene Munsell and Company, Mr. S. O. Filion, Mr. R. Blackburn, Mr. N. Holland, Wallingford Mining and Mica Company; and in Kingston, Messrs. Kent Bros.

Mill of the Tonkin-DuPont Graphite Company at Wilberforce

Graphite

Black Donald

The Black Donald Graphite Company, owning and operating the above mine, were the main producers of graphite in the Province during 1913. The mine and grinding plant are situated about fifteen miles from Calabogie in Renfrew county, the property comprising lots 17 to 20 in the first, second and third concessions of Brougham township.

The mine is operated during the summer months, when sufficient crude ore is taken out to run the mill during the year. Stoping was continued in the east end of the pit.

Electric power for operating the mine and mill machinery is generated at Power House rapids on the Madawaska river. This power plant is owned by the Ontario

Graphite Company and operated by the Black Donald Company; 400 horse-power are developed.

The officers of the company are: Mr. Geo. Bunting, Kansas City, President; Mr. R. F. Bunting, Calabogie, manager; Mr. J. A. Snead, Calabogie, secretary-treasurer.

Thirty men are employed, under Superintendent J. G. Patno.

Tonkin-DuPont

This mine is located on lots 34 and 35 in the sixteenth concession of Monmouth township. Prospecting by core drill was continued during the summer of 1913, and the mill was supplied with ore from the company's mine near Maynooth, shipments being made via Central Ontario railway and Irondale, Bancroft and Ottawa railway.

The Tonkin process of concentration is used in the mill.

The officers of the company are: Mr. J. J. Tonkin, New York, president; Mr. H. G. Tonkin, Wilberforce, manager; Mr. M. DuPont, Atlantic City, treasurer.

New York Graphite Company

This company continued to work their property on lots 9 to 11 in the twenty-second concession, Cardiff township.

A large modern mill was built in the spring of 1913.

Mr. J. W. Brewer is manager, and at date of inspection 35 men were employed.

Fluorspar

The fluorspar deposit, formerly worked by Messrs. Gillespie and Wellington, and located about two miles southwest of Madoc village, was operated for a few months in 1913 by Mr. C. Bowman. The old workings were unwatered and the shaft sunk to a depth of 50 feet.

Silver Refinery

Deloro Mining and Reduction Company

This company continued to operate their plant at Deloro during 1913. The branch line from Marmora station on the Central Ontario railway to the smelter was completed during the summer, doing away with the three-mile wagon haul and facilitating shipping and unloading material.

The schedule of freight rates to Marmora and the tariff of ore prices paid by the company is given in the 1912 Report of the Bureau of Mines.

Mr. S. B. Wright is manager, employing 130 men.

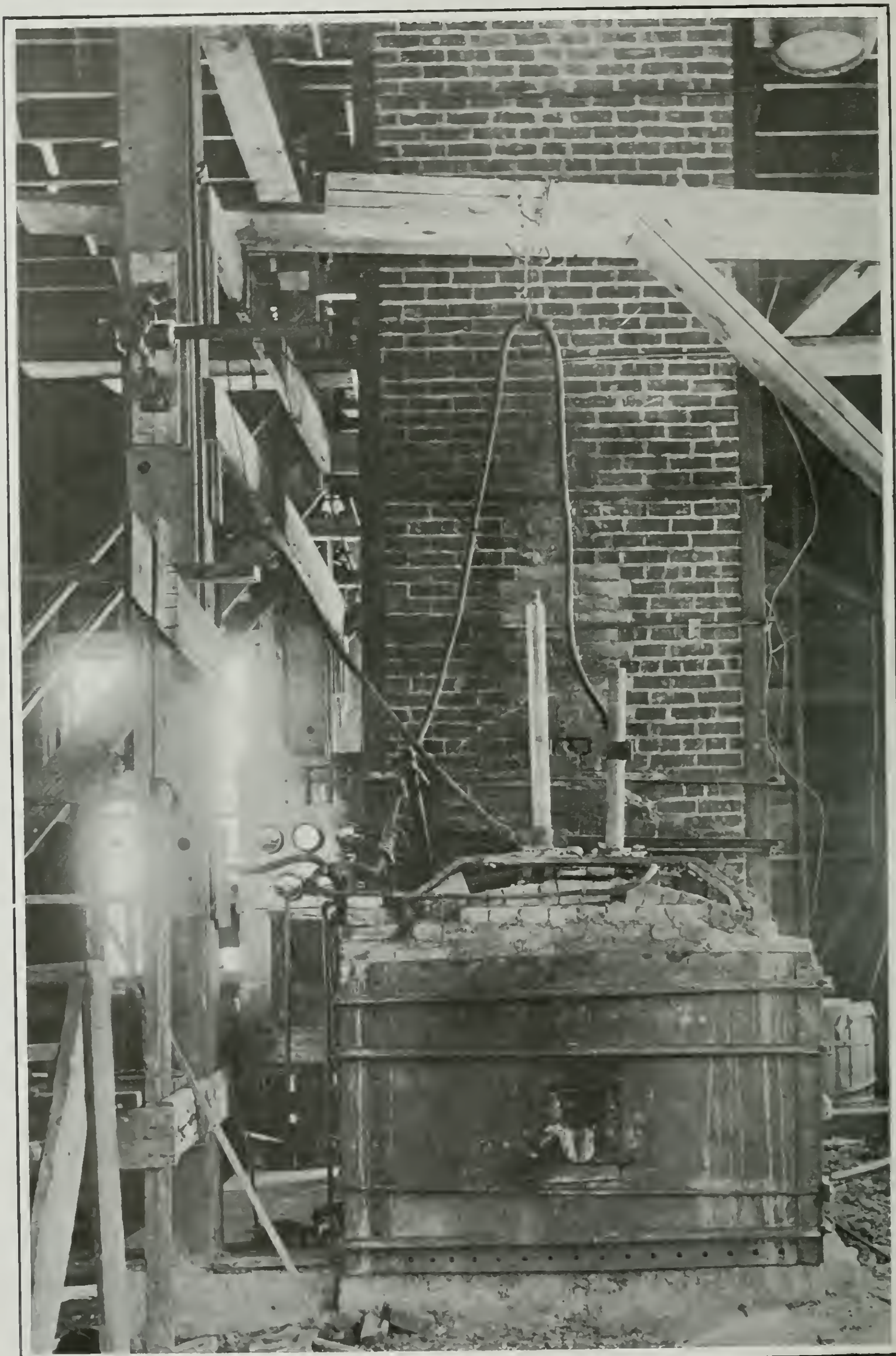
Electric Smelting Plant

Following is a description of a one-ton direct smelting electric furnace plant operated by the Tivani Electric Steel Company, Limited, of Belleville:

The plant consists of two 75-K.W. transformers operating at 90 volts, and supplying power to a 1-ton furnace and the following apparatus: one 7 by 9 inch Dodge rock crusher, one 10-h.p. motor, an elevator to convey the crushed material to the charging floor of the furnace, a complete switchboard with the necessary ammeters, volt meters, oil break switch with contact breaker, etc. The dimensions of the furnace are as follows:

The outside dimensions, including the pre-heater, are 20 feet 9 inches high, by 6 feet, by 4 feet, the furnace hearth being 3 feet 7½ inches by 5 feet 4 inches. The interior of the hearth is 2 feet by 3 feet, and 6 feet deep.

The furnace lining consists of fire brick; magnesite brick and ground magnesite rammed for the sides and bottom, constituting the interior lining. The electrode connections are water-jacketted, and copper pipes half an inch interior diameter, which convey the cooling water to the electrode holders, and the electrode connections, also carry the current.



Electric Furnace, Tivani Steel Company, Belleville

The pre-heater consists of two 14-inch wrought iron pipes eight feet long, supported on four firebrick cylinders, each being 12 inches deep and having a slope increasing regularly in diameter from 14 to 18 inches to allow the charge to slide easily down the heated portion of the pre-heater. These pre-heater pipes are enclosed in the pre-heater stack, which has firebrick linings, and baffle plates with openings arranged in such a manner that the heated gases circulate about the pre-heater pipes.

The furnace is operated on a two-phase current, the transformers being connected by what is known as the Scot connection.

The electrodes are three inches in diameter, threaded so that they can pass down continuously, and are used up entirely, there being practically no loss from short ends. Acheson graphite electrodes are used and pass through water-jacketted electrode holders, and are raised and lowered by levers connected with wrought iron clamps operated by right and left thread screws; these can be raised and lowered at will, one turn of the screw being sufficient to release the clamp in order to take a fresh grip on the electrode when necessary during the operation of the furnace.

The operation of the furnace is as follows: A general return electrode built into the bottom of the furnace is water-jacketted, and an auxiliary electrode is placed near the bottom of the chute of the pre-heater. This can be used when required to assist in melting down the charge as it comes from the pre-heater. By cutting off the currents supplying this electrode the charge is held back during the refining of the charge in the hearth. All the gases from the furnace are utilized in pre-heating and partially reducing the ore, and after passing through the charge they are brought down again mixed with air and burnt round the fire brick cylinders which support the pre-heater pipes. The furnace is charged from the upper floor into the pre-heater. The charge consists of iron ore, limestone and charcoal, crushed to pass through a 1-inch mesh. The charge comes down to the hearth of the furnace, where it is smelted, the furnace working continuously until the hearth is full of metal, the slag being tapped off as required from time to time. When there is a sufficient quantity of metal the charge is held back, and the metal is refined, and when ready is tapped into the moulds for ingots or bars for forging into tools. All grades of carbon steel can be made by regulating the amount of carbon in the form of charcoal mixed in the charge. If the carbon has burnt away too quickly, and there is not sufficient carbon in the metal, this can be remedied before tapping the furnace by addition of charcoal or pig iron. If the carbon is too high, it can be lowered by the addition of low-carbon scrap.

The plant was in operation for about two months, and demonstrated that steel can be made in this manner directly from titaniferous ore containing 7.5 per cent. of titanium. A quantity of high carbon steel was made, the ingots being perfectly sound and free from blow-holes. The company intend to erect a 3-ton furnace during the summer, with a view to making high carbon tool steel and steel castings, and will use the same ore from the Orton mine. The analysis of this ore is as follows:

Iron	50.12 per cent.
Titanium	7.5 per cent.
Vanadium	0.11 per cent.
Nickel	0.34 per cent.
Sulphur	Trace
Phosphorus	0.004 per cent.

The process used is known as the Evans-Stansfield process, the furnace having been designed by J. W. Evans and Dr. Stansfield. Patents have been granted on the furnace, on the process, and on the steel products, in both the United States and Canada, and application is now being made for the British and European patents.

Blast Furnace

Standard Iron Company

This company operated their plant at Deseronto up to November 1st, 1913, and closed down to rebuild the blast furnace. Operations will be resumed in March, 1914.

In the interval the whole plant has been repaired, and the furnace practically rebuilt and enlarged. Ore is brought from the Michigan mines, and a high-grade charcoal pig manufactured.

The officers of the company are: Mr. R. J. Mercur, president, Montreal; Mr. S. F. Belknap, secretary-treasurer, Montreal; Mr. R. H. Watson, manager, Deseronto.

When in operation the plant employed 65 men.

Parry Sound Plant of the Standard Iron Company, Limited

Marble

Ontario Quarries

The Ontario Marble Quarries, Limited, continued to operate their quarries during 1913. The siding to No. 3 quarry has been completed and will be extended to the sawing plant and will connect the three quarries with the main line of the Central Ontario railway, about two miles south of Bancroft.

No. 1 quarry, on lots 28 to 30 in the tenth concession of the township of Dungannon, has an excavation about 100 feet long, 60 feet wide, by 25 feet at the deepest point. The general strike of the belt is north 70 degrees east, in which direction the deposit has been proved by test pits for a distance of 1,000 feet.

No. 2 quarry is located about a quarter of a mile west of No. 1, and the product differs from No. 1 in colour only. In this deposit the marble is found in a variety of colours—pink, white and dark green.

No 3 quarry is situated close to the railway. The marble here is of pure white variety.

The rock is cut by steam-driven channelling machines, and run direct to the gang-saws on tram cars. There are four gang-saws, each containing about forty blades, which can be placed to cut any size.

Mr. Thomas Morrison is in charge of the property, employing 50 men.

Limestone Quarries

Lehigh

At the Lehigh plant of the Canada Cement Company, situated at Point Anne, about six miles east of Belleville, limestone is being quarried for use in the manufacture of cement. A sample of this rock shows the following composition:

	Per cent.
Silica	1.64
Ferric oxide	.53
Alumina	.21
Lime	54.06
Magnesia	.55
CO_2	42.90
SO_3	.40

The rock is loaded into 5-ton cars by a 60-ton Marion shovel, and dumped direct into the large gyratory crusher recently installed near the cement plant. About six acres have been worked out, to an average depth of 20 feet.

Mr. H. L. Shock is manager, employing 35 men in the quarry.

Point Anne

Point Anne Quarries, Limited, considerably increased their output of limestone during 1913.

The company ship crushed stone, rubble, and crib filling. Shipments are made in the company's fleet of boats, and all rail shipments via Canadian Northern, which runs through the north end of the property. The rock is loaded at the quarry by a model 60 Marion steam shovel into cars holding six cubic yards, and hauled by trolley to the crushing plant and bins on the lake shore. This trolley line runs from the Canadian Northern railway line, through the quarry to the loading bins on the shore, a distance of one and one-half miles.

The officers of the company are: Mr. M. J. Haney, president; Mr. J. H. M. Stewart, manager; Mr. A. G. Bennett, superintendent.

Forty men are employed.

Britnell and Company

On part of lots A and B in the sixth concession of the township of Somerville, Victoria county, Britnell and Company operate a sandstone quarry, employing 40 men.

The plant consists of two stiff leg derricks, two double-drum hoists, one 40-h.p. locomotive boiler, one 35-h.p. crusher engine, and one No. 3 Gates crusher.

The company ships rubble, crushed and dimension building stone.

Mr. William Britnell, Toronto, is president, and Mr. Ben. Weaver superintendent of the quarry.

Ontario Rock Company, Limited

During 1913 this company continued operations in their trap rock quarry at Preneveau, near Havelock, in the township of Belmont. All their product was crushed to one inch and under, and shipped to Toronto, for use in road building, for which purpose it is well suited by reason of its extreme toughness.

The plant consists of: one 150-h.p. locomotive boiler, one 100-h.p. return tubular boiler, one 200-h.p. mill engine, one No. 5 Austin gyratory crusher, one 36 by 24 inch Farrel crusher, two 36 by 24 inch Simons disc crushers, three revolving screens.

Mr. Alex. Longwell is president, and Mr. George Reyner superintendent, employing 40 men.

Canada Lime Company

At Coboconk village in Haliburton county the Canada Lime Company are quarrying limestone for use in the manufacture of lime. They have three kilns in operation, two producing ten tons of lime each per 24 hours, and one smaller one, producing six tons per 24 hours.

The plant consists of a double-drum Beatty hoist and one stiff-leg derrick.

The head office of the company is at 34 Yonge Street Toronto. Mr. R. J. Christie is president, and Mr. James Ballantyne superintendent, employing 15 men.

Toronto Brick Company

Near the quarry of the Canada Lime Company at Coboconk village the Toronto Brick Company are quarrying limestone for use in the manufacture of lime. Two kilns are in operation.

The head office of the company is at 64 Wellington street, Toronto. Mr. F. B. Allen is secretary, and Mr. C. M. Callan superintendent, employing 12 men.

Hastings Quarry

On lot 11 in the thirteenth concession of Hungerford township, near Actinolite, Hastings Quarries, Limited, operated their limestone quarry during the summer months.

The plant consists of a 100-h.p. marine boiler, one 75-h.p. mill engine, two Champion jaw crushers, Nos. 4 and 5; one revolving screen, 18 feet in length by 50 inches in diameter.

A 5-pocket storage bin of 400 tons capacity has been erected.

Mr. John Grant is manager, employing at the date of inspection 20 men.

Quinlan and Robertson

On lot 10 in the ninth concession of Huntington township, near the village of Crookston, on the Madoc branch of the Grand Trunk railway, Messrs. Quinlan and Robertson erected a crushing plant and storage bins, for grinding the refuse limestone from operations carried on some years ago. At that time only dimension stone was shipped, and several years of quarrying left a large amount of waste rock.

One No. 4 Gates and one No. 5 McCulla crusher were installed, with a screening plant and storage pockets.

Mr. W. E. Tummon is in charge, employing 15 men.

Tweed Quarries

On part of lots 15 and 16 in the eleventh concession of Hungerford township, Tweed Quarries, Limited, opened up a granite quarry during the summer of 1913. A siding was built from the Toronto-Ottawa line of the Canadian Pacific railway and storage bins erected.

The officers of the company are: Mr. L. M. Dwyer, president, Tweed; Mr. J. Marchand, secretary, Tweed; Mr. James Pearson, manager.

At the date of inspection 40 men were employed, chiefly in construction work.

Kingston Quarry

In the city limits of Kingston several small limestone quarries were worked intermittently during 1913.

Henry MacRow operated the Montreal Street quarry under lease from the city. The plant consisted of two Climax crushers, and two revolving screens, driven by three Sawyer-Massey threshing engines. The crushed stone was sold to the city for street building.

Twenty men were employed during the summer months.

Delta Lime Company

On lot 27, in the eighth concession of the township of Bastard, the Delta Lime Company quarry crystalline limestone for use in the manufacture of lime. The product is hauled to Delta village, where one kiln was in operation during the summer months. The kiln has a capacity of 150 bushels of white lime per 24 hours.

Mr. Omar Brown is manager.

Robillard's Quarry

On lots 22 and 23 in the first concession of Gloucester township, about two and one-half miles east of Ottawa, Mr. B. E. Robillard quarried limestone during 1913. Dimension stone for building purposes and white lime are shipped, chiefly to the trade in Ottawa.

Two kilns, with a capacity of 700 bushels per day, were in operation on the date of inspection.

Thirty men are employed, under the supervision of Mr. Robillard.

Gosselin's Quarry

A short distance east of Messrs. Robillard's quarry, in Gloucester township, Mr. C. Gosselin has opened up a quarry in Trenton limestone, and during the summer of 1913 employed 10 men in getting out dimension stone for the building trade.

Eganville Quarry

In the township of Grattan, a short distance east of the village of Eganville, the Standard Chemical Iron and Lumber Company operated their limestone quarry for use in the manufacture of lime.

Two kilns were in operation, with a combined capacity of 900 bushels of white lime per day.

Mr. A. B. Arveson is manager, employing 35 men.

York Sand and Gravel Company

About one and one-half miles east of York, near the main line of the Grand Trunk railway, the York Sand and Gravel Company are excavating sand and gravel for use in the building trade.

The plant consists of one Brown locomotive crane and one Beatty travelling derrick, with a capacity of 15 tons. A screening plant separates the sand and gravel, and both products are loaded into cars for shipment to the trade in Toronto.

Mr. C. S. Richards is manager, employing 25 men.

Excavations for Clay

Don Valley

At the Don Valley Brick Works, situated in the Don Valley, Toronto, sand, clay and shale are quarried for use in the manufacture of brick. The circular shale pit, about 200 feet in diameter, has now reached a depth of 65 feet, and the clay above the shale is excavated by two steam shovels. The loaded cars are lowered by gravity trams to the brick plant.

Mr. Robert Davies owns the plant. Mr. William Burgess is superintendent, employing 45 men in the clay and shale pits.

The excavations of the following companies, engaged in the manufacture of brick in Toronto and vicinity, have been inspected during the year:

Bell Bros., Greenwood Avenue.
Prices, Limited, Greenwood Avenue.
Standard Brick Company, Limited, 532 Greenwood Avenue.
John Logan, Greenwood Avenue.
John Price, Greenwood Avenue.
A. H. Wagstaff, 362 Greenwood Avenue.
Sun Brick Company, Don Valley.
Port Credit Brick Company, Port Credit.
John Pears, Eglinton Avenue.

V.—SOUTHWESTERN ONTARIO

For inspection purposes, southwestern Ontario comprises all that part of Ontario south of a line drawn from Toronto to Key Harbor on Georgian Bay. The industries in this area, which are subject to the provisions of the Mining Act, include silver smelting plants, blast furnaces, gypsum mines, quarries, excavations in brick yards, sand and gravel pits and lime kilns.

The mining of gypsum in the valley of the Grand river has been carried on for many years, and each year shows an increased demand for gypsum products.

The quarries in this part of Ontario are growing in importance yearly, while the production of clay and shale for use in the manufacture of brick and allied products has almost doubled in recent years.

Attention was directed in the Report of the Bureau of Mines, 1913, to the carelessness shown in the operation of their works by quarry owners and brick manufacturers. The warning there given needs to be repeated. A careful study of the Accident list for 1913 will show that in nearly every instance the accidents in quarries and clay excavations during the year could have been avoided by careful supervision on the part of foremen in charge. In many investigations it has been brought out that even ordinary precautions were neglected and the men left to their own resources. Foreigners who understand English fairly well often do not thoroughly comprehend orders, and for that reason it is not sufficient for a foreman to give an order or warning—it is his duty to see that it is understood and carried out. There is still a great deal of carelessness shown in the handling of dynamite by quarrymen. This is due generally to ignorance of its properties, and of the numerous causes which result in premature explosions.

Silver Refineries

Coniagas Reduction Company

This company continued to operate its refinery at Thorold for the treatment of the Coniagas ore and custom ores from the Cobalt camp.

The tariff of prices paid for ores is given in the 1913 Report of the Bureau of Mines.

Refined silver and arsenic are produced, also the oxides of cobalt and nickel.

Mr. R. L. Peek is superintendent.

Canada Refining and Smelting Company

This plant, located within the town limits of Orillia on the Grand Trunk railway, was built in the fall of 1910, to treat Cobalt ores, and smelting operations were started in February, 1911. It operated continuously till January, 1913, when part of the plant was destroyed by fire. It was rebuilt in the fall of 1913, and on the date of inspection in February, 1914, was ready for operation. The plant has been reconstructed and several changes made to meet new conditions and requirements. An 80-foot rotary roaster replaces the hand-rabbled furnace formerly in use. A 60 by 60-foot bag house has been constructed for the crude arsenic, and 30 by 30-foot for the refined product.

Electric power purchased from the town of Orillia is used throughout the plant.

The officers are: President, Mr. H. T. Smith, Providence; secretary-treasurer, Mr. A. E. Stevens, Providence; manager, Mr. Charles Holding, Orillia; superintendent, Mr. E. A. Gethardt, Orillia.

Blast Furnaces

The Steel Company of Canada continued to operate their furnaces at Hamilton on an enlarged scale during the year. This company is an amalgamation of the Hamilton Steel and Iron Company with The Canada Bolt and Nut Company, Canada Screw Company, Dominion Wire Manufacturing Company, and the Montreal Rolling Mills Company.

The head office is in Hamilton, Mr. R. Hobson being president and Mr. H. H. Champ treasurer.

The company operate two blast furnaces and an open-hearth plant. The officials of this company deserve to be commended for the efficient safety and first aid organization arranged for their employees. Other furnace companies, though operating on a smaller scale, would do well to study the plan in force at this plant, and similar results could easily be attained.

Midland

The Canada Iron Corporation had two furnaces in blast and employed about 175 men when in operation. In the latter part of the year their plant was closed to effect a financial rearrangement.

Mr. A. C. Adams is manager.

Port Colborne

The Canadian Furnace Company began operations in September, 1913, at their new plant, Port Colborne, for the manufacture of pig iron. The plant is situated at the junction of the Welland canal and Lake Erie, with a frontage of 2,200 feet on the canal, which will all be converted into dockage as soon as improvements can be carried out.

Ore is brought from Lake Superior points and from the company's mine at Belmont in Hastings county.

The capital stock of the Canadian Furnace Company is owned by the Buffalo Union Furnace Company, Buffalo, N.Y., and the plant is being operated by them to supply the Canadian market.

The whole plant is of modern construction in every respect.

In the storage bins, there is sufficient capacity to store about 250,000 tons of ore and 100,000 tons of limestone for use, between navigation periods. The furnace is 80 feet high, 13½ feet in diameter at the hearth, 19½ feet in diameter at the bosh, and 13½ feet in diameter at the stock line. Air is supplied through ten tuyeres.

The bosh and hearth are fitted with 119 water-cooled bronze plates.

At the top of the furnace the charging apparatus is manufactured under the A. G. McKee patent, a feature of which is the receiving hopper, which is conical in form, resting on ball bearings supported on top of the gas seal.

The cast house is a steel structure 200 feet long from the centre line of the furnace, and 65 feet wide.

Later on the company intend to instal a pig-casting machine for the manufacture of chill cast basic iron. By this process the iron is tapped from the furnace into a large ladle, where it is thoroughly mixed, and then poured into iron moulds carried on an endless belt. Contact with the sand is avoided and perfect uniformity of composition assured.

The officers of the company are: president, Mr. Frank B. Baird; vice-presidents, Mr. Harry Yates and Mr. C. C. Collins; secretary, Mr. R. F. Schelling.

The manager is Mr. B. Marron, employing 175 men.

Parry Sound

At Parry Sound, the Standard Iron Company erected a modern furnace plant for the manufacture of charcoal pig iron, and began operations in July 1913. Charcoal is purchased from the Canada Chemical Company whose plant is near the blast furnace.

The plant at Parry Sound consists of one modern type blast furnace, three Robb boilers, 200 h.p. each, one Fraser and Chalmers blower, capacity 12,000 cubic feet of air per minute, two Brown hoists, one Otis elevator hoist, ore dock and travelling cranes.

Mr. R. H. Watson is manager and Mr. J. A. Murphy superintendent, employing on the date of inspection 75 men.

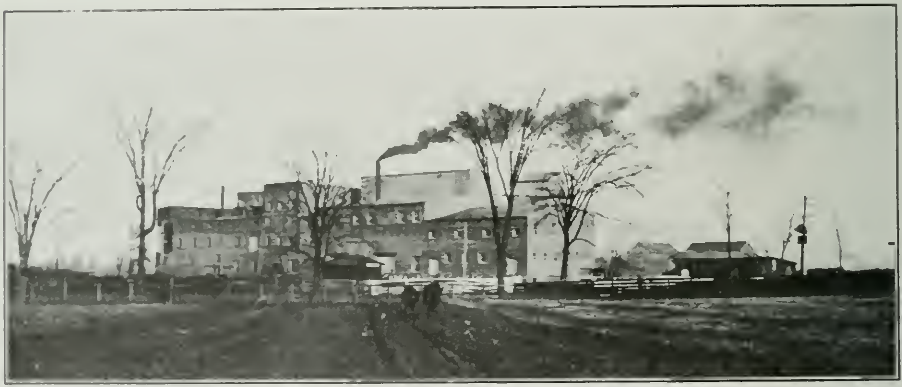
Gypsum

Near the town of Caledonia, on lots 10 and 11 in the first range, township of Seneca, the Alabastine Company, Limited, operated their gypsum mine and plant for the manufacture of gypsum products continuously during 1913.

The gypsum is high-grade and occurs in a flat-lying bed about 80 feet below the surface. It is mined by the pillar and room method, the ore being hoisted through an incline shaft, an auxiliary vertical shaft being also provided. Drilling is done by electric rotary drills.

During the year the storage bins of the company, near the Grand Trunk railway station, were burned, and a new building erected at the mine.

Mr. A. J. Parkhurst is manager, employing 125 men in the mine and mill.



Plant of Crown Gypsum Company at Lythmore

Carson Mine

This mine, owned and operated by the Alabastine Company, is situated about three miles south of Caledonia. A good quality of white gypsum is mined here and teamed to the mill at Caledonia. The workings now extend over an area about 350 feet long by 250 feet wide.

The waste rock is used for pillars. A vertical air shaft about 75 feet deep has been sunk, at a distance of 800 feet from the mouth of the main incline shaft. The gypsum bed is about four feet in thickness.

The mine is operated during the summer months.

The Haldimand Gypsum Company

The above company has been organized to work a gypsum property situated about one mile west of the Alabastine plant near Caledonia.

A 2-compartment vertical shaft, 11 by 7 feet, has been sunk to a depth of 61 feet.

Mr. James Old, Toronto, is president of the company, and on the date of inspection all work was in charge of contractor James Blake, of Caledonia.

Crown Gypsum Company

The mine operated by this company was formerly known as the Martindale mine, and is situated on lots 58 and 59, Oneida township, county of Haldimand.

The workings are reached by an incline shaft about 500 feet in length, sunk from the west side of the deposit. The gypsum bed, about four feet in thickness, is mined by the pillar and room method, the waste rock being left to support the roof as pillars.

A narrow-gauge railway connects the mine with the Michigan Central railway at Lythmore station, where the grinding plant of the company is situated.

The officers of the company are:—Mr. W. G. Case, president, Buffalo, N.Y.; Mr. C. E. Williams, manager, Lythmore, Ont.; Mr. G. C. Fischle, superintendent, Lythmore, Ont.

Thirty men are employed at the mine and 15 at the mill.

Quarries

Battle Quarry

This quarry, situated in the town of Thorold, has been closed for the past three years. Some years ago a large quantity of stone was supplied from this quarry for use in the construction of the old Welland canal. It is probable that the new work now being carried on in connection with the new canal will revive the quarry industry in the vicinity of Thorold.

Canadian Quarries

Near Stoney Creek, in Saltfleet township, the Canadian Quarries, Limited, opened up a quarry for the production of crushed limestone.

Mr. O. E. Quigley, of 26 Fairleigh Avenue, Hamilton, is manager, employing 20 men.

Canada Cement Company

Near Port Colborne, the Canada Cement Company are engaged in quarrying limestone and excavating clay for use in the manufacture of cement.

The working face in the quarry averages 20 feet in depth, and 5-inch holes are drilled by a Clipper deep-well machine. Two Marion steam shovels load the broken rock into cars. Electric power purchased from the Ontario Power Company is used to operate the quarry machinery.

Mr. S. R. Preston is manager, employing 25 men in the quarry.

Cartmell Quarry

Within the town limits of Thorold, William Cartmell worked the above quarry at intervals during the year. At the date of inspection four men were employed. Mr. Cartmell ships dimension stone and rubble.

Canada Crushed Stone Corporation

Near the town of Dundas, on lots 12 to 15, in the first concession of the township of West Flamboro, the above company (successors to Doolittle and Wilcox) are quarrying limestone.

The crushing plant is one of the largest in the Province, and was fully described in the Report of the Bureau of Mines for 1912.

Work on a large scale was continued during 1913.

Mr. J. D. Small is superintendent, employing 60 men.

Chalmers Quarry

On the west side of Owen Sound Mr. David Chalmers operates a quarry for use in the production of lime. The kiln is situated about 500 feet from the quarry, and the broken limestone is hauled in carts and dumped directly into the kiln.

Five men are employed.

Empire Limestone Company

During 1913 this company continued to operate their quarry and sand pit on lots 4 to 6, in the first concession of the township of Humberstone. Most of the product is shipped to Buffalo, about 14 miles distant. An area of about 16 acres has been worked over, and the quarry at the present level has reached the limit of its northern boundary. An additional Browning hoist and clam shell were put in operation during the year in the sand pit on the lake shore.

The plant is operated entirely with steam, and has been described in previous reports of the Bureau of Mines.

Mr. T. R. Thomas is manager, employing on the date of inspection in July, 1913, 125 men.

Fleming Quarry

In the ninth concession of the township of Esquesing, and a short distance east of the Logan quarry, Mr. J. Fleming is quarrying limestone, employing 30 men throughout the year.

The plant consists of two guyed and one stiff-leg derrick, one double-drum Beatty hoist. The product is shipped in the form of dimension building stone and rubble.

Mr. M. G. Bell is manager.

Gallagher Lime and Stone Company

On lot 15, in the sixth concession of Barton township, this company are quarrying limestone for use in the manufacture of lime. The company also ships rubble and dimension stone, principally to the trade in Hamilton.

Mr. Dan A. Gallagher, Hamilton, is manager of the company, employing 10 men.

Hagersville

On lot 14, in the thirteenth concession township of Walpole, The Hagersville Contracting Company operated their limestone quarry continuously during 1913. This quarry is one of the oldest in the Province, and a large area has been worked out.

Mr. J. C. Ingles is manager, employing 45 men.

Hagersville Crushed Stone Company

About one mile east of the town of Hagersville, on the line of the Michigan Central railway, the above company opened up a limestone quarry and operated it till December 1st, 1913. The plant consists of one 60-h.p. locomotive type boiler, one No. 4 Austin crusher, one No. 5 Gates crusher, and a screening plant.

Mr. Robert Hambleton is manager, and when operating employs 20 men.

Harrison and Beatty

About two miles south of Owen Sound, on the Beatty farm in Sydenham township, Messrs. Harrison & Beatty, of Owen Sound, opened up a limestone quarry for the production of rubble stone and all sizes up to two inches. A siding from the Canadian Pacific railway has been built to the plant, and storage bins erected. The plant consists of one double-drum Maundy hoist, one 25-h.p. upright boiler, one 25-h.p. return tubular boiler, one No. 4 Austin crusher.

Mr. Robert Nelson is superintendent, employing 10 men.

Harvey

Near the village of Rockwood, Messrs. E. Harvey, Limited, quarry limestone for use in the manufacture of white lime. Three kilns are in operation. Hydro-electric power is used to run the quarry machinery and kiln fans.

Mr. E. Harvey is manager, employing 25 men.

Longford

At Longford Mills in Rama township, about seven miles south of Orillia, the Longford Quarry Company operate a limestone quarry for the production of dimension building stone.

Mr. William Thomson, Orillia, is president, and Mr. John Meikle superintendent, employing 27 men.

Logan

On lot 27, in the eighth concession township of Esquesing, Mr. Hugh Logan is operating a limestone quarry, shipping dimension stone and rubble. The output is hauled to the Grand Trunk siding near Glen Williams.

Thirty-eight men are employed.

Michigan Central

Near the town of Hagersville, and adjoining the quarry of the Hagersville Contracting Company, the Michigan Central Railway Company operated their limestone quarry during the summer months of 1913. An area of ten acres has been worked out to an average depth of twenty feet.

The output is used by the railway company for surfacing material, and some dimension stone is quarried for use in pier construction.

Mr. D. E. Cronin is superintendent, and on the date of the inspection 60 men were employed.

Marshall

On lot 14, concession 7, Barton township, about two miles from the city of Hamilton, Mr. James Marshall quarries limestone for use in the manufacture of lime. During the summer months 25 men are employed.

Oliver and Webster

Within the town limits of Owen Sound on the east side, Messrs. Oliver and Webster quarry a 13-foot face of limestone. Electric power is purchased from the municipality to operate the quarry and crushing machinery. The product is shipped as rubble and crushed stone.

Mr. Keith Webster is manager, employing 40 men.

Owen Sound Lime Works

On the west side of the town of Owen Sound the above company quarry limestone for use in the manufacture of lime. The kilns have a capacity of 400 bushels per 24 hours.

Mr. Oliver Brown is owner and manager, employing seven men.

Queenston

On lots 47 and 48, in the third and fourth concessions of Niagara township, near the village of St. Davids, the Queenston Quarry Company are quarrying limestone for use as building material and also as crushed stone for road material and concrete work.

The equipment consists of: 4 double-drum Beatty hoists with derricks, 1 Belleville hoist and an A frame sand clam shell derrick with Beatty hoist. These hoists are all steam operated, with six small upright boilers.

A 350-cubic foot compressor, motor-driven, supplies air for the drills.

The crushing plant is equipped with a No. 5 Austin crusher and a Simons disc crusher, both motor-driven. Electric power is purchased from the Ontario Distributing Company.

Mr. Charles Lowery is manager, employing 60 men.

St. Mary's Horse Shoe Quarry

This quarry is situated within the town limits of St. Mary's, and during the summer months of 1913 was operated by the present owner, Mr. R. H. McWilliams.

Three acres have been worked out to an average depth of 45 feet. Hydro-electric power is used to operate the quarry and crushing machinery. Work was discontinued in November.

Twenty-five men were employed on the date of inspection.

St. Mary's Portland Cement Company

Within the town limits of St. Mary's, in Perth county, the above company are quarrying limestone and excavating clay for use in the manufacture of cement. The broken rock is handled by three stiff-leg derricks, and dumped direct to a No. 8 Kennedy gyratory crusher. The crushed material is carried to the mill on a belt conveyor 300 feet in length. A 1,250 cubic foot Imperial Type 10 compressor supplies air for the drills.

The quarry has now an average depth of 40 feet, including 10 feet of overburden. The plant began operations in 1912, and in 1913 400,000 barrels of cement were manufactured.

A safety committee of officers and employees meets regularly, and all precautions are taken both in the quarry and cement plant to minimize accidents among the workmen.

The officers of the company are: president, Mr. George H. Gooderham, Toronto. secretary, Mr. Mark Irish, Toronto; manager, Mr. J. G. Lind, St. Mary's.

Forty men are employed in the quarry.

Standard White Lime Company

This company operate under one management four limestone quarries in south-western Ontario, manufacturing lime. At St. Mary's there are two kilns, and 15 men are employed under Mr. James Sclater. In Puslinch township, just outside the western city limits of Guelph, there are three kilns, with a combined capacity of 20 tons of lime per day. At this point the company have in operation a large hydrating plant. Twenty-two men are employed, under Mr. George Gates.

In Guelph city there are two kilns in operation, and here the quarry has an average depth of 15 feet. Fifteen men are employed, under Mr. D. Wardell.

At Beechville, near Ingersoll, the company operate a large quarry, employing 40 men. Hydro power is used at all the plants.

Mr. Kennedy is manager of the company.

Thames Quarry

In St. Mary's the Thames Quarry Company operated their limestone quarry continuously during 1913. The rock here is of excellent quality, both for fluxing material and road-making.

Crushed stone, rubble and dimension stone for building purposes are shipped. In 1913 the output was considerably increased, the bulk of the rock going to the cities and municipalities for use in road-making. The quarry is now 600 feet long by 250 feet wide, with an average depth of 37 feet. The company have recently erected a plant for the manufacture of cement brick at the northeast end of the quarry. The fine material and waste rock will be used in this plant.

Mr. David Bonis is president, and Mr. John Bonis manager and secretary.

Thirty men are employed in the quarry and crushing plant.

Toronto Lime Company

At Limehouse, in the township of Esquesing, and at Dolly Varden, on lot 23, in the third and fourth concessions of the township of Esquesing, the above company quarry limestone for use in the manufacture of lime.

At Limehouse there are two kilns in operation, with an output of 30 tons of lime per day, and at Dolly Varden there are two kilns, with a combined capacity of 14 tons.

Mr. William Gowdy is manager, employing 40 men at Limehouse and 25 at Dolly Varden.

Wentworth

On lot 4, in the fifth concession township of Saltfleet, the Wentworth Quarry Company operated continuously during 1913.

The limestone is crushed and sized, and five products shipped—rock sand, ¼-inch, ½-inch, 1-inch and 2-inch rock. The plant was fully described in the 1913 Report of the Bureau of Mines.

Mr. F. W. Schwendiman is manager, employing 30 men.

Welland County Lime Works

About three miles west of Port Colborne, in the township of Wainfleet, two limestone quarries are being worked by the above company. From quarry No. 1 limestone of excellent burning quality is produced for the manufacture of lime. No. 2 quarry is operated for rubble only.

Mr. John Reeb is manager, employing 10 men.

Walker's Quarry

In the town of Thorold Mr. David Walker employs 12 men excavating dimension stone and rubble. The quarry is 40 feet in depth.

Canada Iron Corporation

On lots 5 and 6, front range of Rama township, the above company operate a limestone quarry for the production of fluxing material, for use in their blast furnaces at Midland.

Mr. Fred Morgan is superintendent, employing at the date of inspection 75 men.

The material is loaded on cars at the quarry near Longford Mills and shipped via Grand Trunk railway to Midland.

SAND AND GRAVEL

The excavations of the following companies producing sand and gravel were inspected during the year:

The Armstrong Supply Company, Hamilton.
Bartonville Gravel Pit, Hamilton.
Clifton Sand and Gravel Company, Stamford.
W. M. Webb, gravel pit, Hamilton.
Yates gravel pit, Hamilton.
Edward New, gravel pit, Hamilton.
Kingston Sand and Gravel Company, Kingston.

The shale and clay excavations of the following companies, engaged in the manufacture of brick, were inspected during the year:

Brandon Pressed Brick and Tile Company, Milton.
Barton Pressed Brick Company, Bartonville.
Breslau Brick Company, Breslau.
Crawford Bros., Hamilton.
W. H. Cooper, Hamilton.
Canadian Pressed Brick Company, Hamilton.
Halton Brick Company, Terra Cotta.
Milton Pressed Brick Company, Milton.
George E. Mills, Hamilton.
Edward New, Hamilton.
Ollman Bros., Hamilton.
Owen Sound Brick Company, Owen Sound.
Paxton and Bray, St. Catharines.
Toronto Pressed Brick Company, Milton.
Terra Cotta Pressed Brick Company, Terra Cotta.

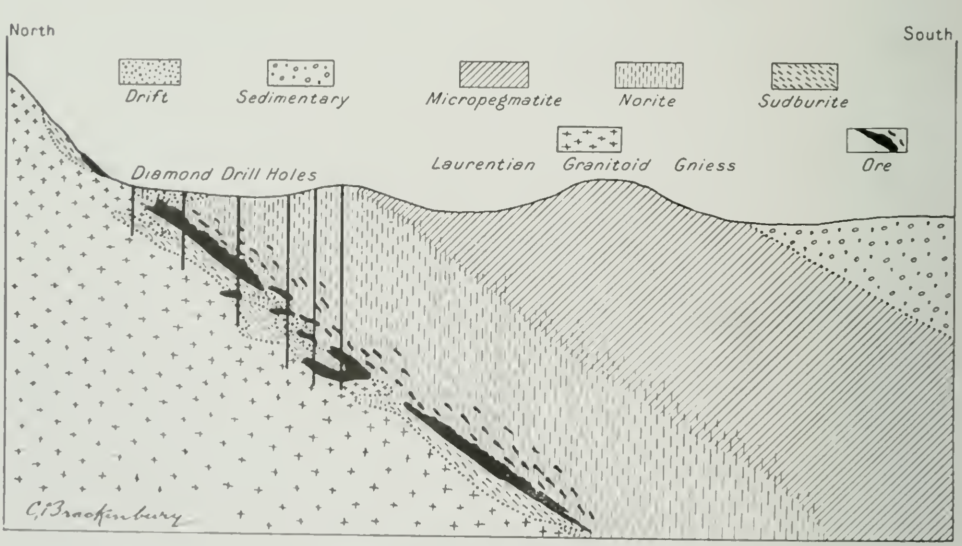
NOTES ON THE ROCKS AT LEVACK

By C. Brackenbury

Last year diamond-drilling operations were carried on under the writer's charge in Levack township, on the northern side of the Sudbury Nickel field. A marked feature in the drill cores was the continual recurrence of a very fine-grained moderately basic-looking grayish rock, the true character of which could not be determined satisfactorily in the field. This rock was generally found either directly adjoining, or in close proximity to, the ore body, and also in contact with the Laurentian granitoid-gneiss.

In order to determine the true character of the fine-textured gray rock, to name it correctly, and ascertain its proper relationship with the ore body and the surrounding country, sections of some of the rock samples were made and examined microscopically at the University of Toronto. Altogether 29 sections were examined, the results showing that they may be classified as follows:

A. Sudburite (older norite)—1, 2, 3, 4, 5, 6, 7, 8, 9.
B. Norite (nickel-bearing eruptive)—10, 11, 12.
C. Altered or transition rocks, some of which may be derived from sudburite—13, 14, 15, 16, 17, 18.
D. Local types, partly micropegmatitic—19, 20, 21, 22.
E. Micropegmatite—23, 24.
F. Laurentian, granitoid-gneiss and more basic phases—25, 26, 27, 28.
G. Olivene-diabase dike—29.



Ideal Section, Levack Township

A—Sudburite

Sections 1 and 2 show the most characteristic features of this rock, and may be described as typical examples. Under the microscope about half the rock is seen to consist of plagioclase, and about one-third of the monoclinic pyroxenes diallage and augite, the remainder being made up of magnetite, a little secondary amphibole and a little orthorhombic pyroxene, probably hypersthene or enstatite. The extinction angles of the plagioclase are those of labradorite and bytownite, and the crystals are small and broad, with few twin lamellæ. Much of the pyroxene shows the fibrous and herringbone structure of diallage and there is some uralitization. The greater portion shows oblique extinction, but in a few places a little pyroxene may be seen with parallel extinction, and slight pleochroism, showing the presence of hypersthene or enstatite. The magnetite, like the plagioclase and pyroxene, is distributed throughout the rock. It appears chiefly as irregularly shaped grains of moderate and of minute sizes. The amphibole is chiefly the pale green fibrous variety uralite, and is plainly a secondary mineral derived from the pyroxene. There is also a little pale green-brown hornblende.

Sections 1 and 2 show no biotite, but there is a little to be seen in sections 3, 4, 5, 6, 7, and 9. Quartz is present in 3, 4, and 5, in small quantity, and other occasional accessories are apatite and calcite. No. 8 contains more plagioclase and less pyroxene than the average. Hypersthene is plainly to be seen in sections 3, 8, and 9.

Sections 1 and 2 represent greenstone rocks outcropping at the edge of the muskeg swamp, in contact with, and overlying, the Laurentian granitoid-gneiss. Both these rocks appear to the eye as close-grained, compact and greenish-gray. No. 1 was much iron stained and No. 2 very magnetic. All the other sections under this heading represent pieces of core taken from the diamond drill holes at various depths. The rock represented by these cores was generally found near the ore deposit, either underlying the main body or enclosed within portions of the pyrrhotite, and in some cases penetrating the Laurentian one or two hundred feet from the norite contact.

Section 3 represents a piece of core taken from near the bottom of the ore body, where it was very thick. This core came from a depth of 700 feet below the surface, and at about the same distance horizontally from the outcrop. A good deal of similar gray rock and small portions of granitic rock were found in several places above. The main body of the Laurentian gneiss was apparently entered at a depth of 750 feet to 790 feet. Under the microscope this section shows the typical plagioclase of the older norite, consisting of small, short, stout crystals with few lamellæ and extinction angles of labradorite and bytownite. The plagioclase makes up about half the rock. The pyroxene occurs in fairly large aggregates, partly amphibolized. There is more hypersthene present than in sections 1 and 2, and a good deal of the diallage has been altered to uralite in the same way. The magnetite is typical, being scattered through the rock in moderate and minute grains. A little biotite and quartz are present.

Section 4 represents a piece of core from a drill-hole put down about 200 feet south of the base of the Laurentian hill. This piece of core was taken from near the bottom of the ore body at a depth of about 440 feet and just above a six-foot layer of good pyrrhotite. Microscopically, it differs from Nos. 1 and 2 in showing larger irregular aggregates of pyroxene, and there is more hornblende present.

Section 5 comes from a piece of core in the same hole at a depth of 451 feet, that is, just below the last six feet of ore, and just above an included or protruding mass of the granitoid-gneiss. This section shows less magnetite than is typical, but a good deal of quartz and biotite. The presence of so much quartz is perhaps due to the proximity of the granitoid-gneiss.

Section 6 comes from core in the same hole as Nos. 4, 5, and 25, at a depth of 467 feet, and just below this at 468 feet the main body of the granitoid-gneiss is entered. The peculiar feature of this section is the presence of a secondary light-brown hornblende which occurs throughout intimately mixed with the pyroxene. The plagioclase and magnetite are fairly typical. No quartz was noticed.

Section 7 represents core from the same hole as Nos. 10, 19, 20, 21, 22, that is at a distance of about 800 feet from the outcrop, but the depth is not specified. To the eye it is the usual fine-grained compact gray rock. Examined under the microscope it is seen that about half the rock is plagioclase (labradorite), with crystal boundaries mostly crowded together and not freely formed. The individuals are generally larger than in sudburite (older norite), but not so large or well formed as in norite. They have the short, broad shape characteristic of sudburite, but rather more lamellæ than is usual. The pyroxenes form an indefinite aggregate with amphiboles. There are indications of hypersthene, augite and diallage largely altered to a pale green-brown hornblende and uralite. The whole aggregate is impregnated with magnetite, chiefly in minute grains. A very little biotite is present as small specks. The rock is probably the older norite, but might be placed under heading C.

Sections 8 and 9 are interesting, as the cores were taken from depths of about 200 feet and 100 feet respectively below the surface of the steeply inclined Laurentian hill where it rises to the north of the muskeg swamp. Neither of these holes proved up any ore, but they have now shown that the compact feldspathic gray rock which they penetrated at various points down to depths of 100 feet and 200 feet, is really the older norite. It is plain, then, that the sudburite here penetrates crevices and hollows in the Laurentian formation. This, with the evidence of the other bore holes passing through the ore body, and that of the outcropping rocks represented by sections No. 1 and 2, clearly indicates that the sudburite occurs here, probably in the form of an eruptive sheet, generally underlying the nickel-bearing norite, and overlying, and in some places even penetrating, the Laurentian granite.

Under the microscope sections 8 and 9 are somewhat similar. In section 8 about two-thirds of the rock is made up of the typical plagioclase of the sudburite. In section 9 the proportion of plagioclase is somewhat less. The pyroxenes, diallage and hypersthene, occur in fairly large, irregularly shaped grains, which show much weathering, with formation of the usual secondary products hornblende and uralite. The magnetite is more typical in section 9 than in 8, where it occurs in larger grains, but is not quite so persistent as usual. There is a little biotite in 9, but not in 8. Apatite occurs in both as small scattered crystals. A little epidote and a few specks of pyrite are present in 8, and some calcite in 9. The typical features of sudburite are shown in the plagioclase, pyroxenes and magnetite.

B—Norite, The Nickel=Bearing Eruptive

Sections 10 and 11 are excellent examples of the basic phase of norite and show the presence of pyrrhotite with much fresh hypersthene. In 10, plagioclase occupies about half the rock and pyroxene about one-third. In section 11 it is the other way about, with pyroxene taking up about half and plagioclase about a third of the rock. The plagioclase shows extinction angles of labradorite and bytownite. The pyroxene is chiefly rhombic, with pale pink to green pleochroic colors, and occurs as fresh-looking crystals of hypersthene. There is also present a little monoclinic pyroxene as augite and diallage, the latter having been slightly amphibolized in places, forming small irregular spots of secondary hornblende or uralite. A good deal of pyrrhotite is present as irregular grains and patches. Biotite is quite conspicuous, and accessories occurring in small quantities are chalcopyrite, quartz, magnetite and apatite. The plagioclase occurs in well-formed crystals of moderate size. The hypersthene also shows some fairly well-formed crystals, but the crystal boundaries of the other minerals are not usually well developed. The pyrrhotite shows no vein structure, but occurs disseminated through the rock like the other minerals, indicating that it has separated out from the original molten magma in the same way, that is to say, by a process of magmatic segregation.

The cores represented by sections 10 and 11 were taken from drill-holes at 800 feet and 600 feet from the outcrop and less than 200 feet above the pyrrhotite ore body. Megascopically, the rock is of medium texture, greenish-gray in color, showing feldspar and a dark mineral, some of which is hornblende. A few specks of biotite and pyrrhotite can generally be distinguished.

Section 12 shows a weathered and somewhat less basic phase of the norite. Megascopically, the rock is medium-grained, gray, feldspathic with pyroxene or hornblende and some biotite. Under the microscope about half the rock is found to consist of plagioclase with extinction angles of labradorite and bytownite. Most of the individual crystals are smaller than those in sections 10 and 11, but larger than those to be seen in sections of sudburite, and a few crystals are quite large. The pyroxene has been badly weathered and much of it is altered to hornblende, but in the section there are three or four large pieces of diallage left, which are wrapped round feldspar crystals, showing a well-marked ophitic structure.

No hypersthene can be distinguished. The pyroxene makes up about an eighth of the rock, and hornblende, uralite and biotite about a quarter. Quartz is quite conspicuous, and occurs as a coarse intergrowth with the feldspar, giving an almost pegmatitic appearance in places. A few small pieces of magnetite and pyrite are present.

The core for this section was taken from a depth of about 330 feet and at a distance of about 1,000 feet from the outcrop. The position of this core was much farther from the ore body than in cases Nos. 10 and 11.

C—Altered or Transition Rocks

Sections 13, 14, 15, 16, 17, 18 show altered or transition rocks, which do not have, in any single case, the chief characteristic features of the sudburite or of the nickel-bearing norite.

Section 13 represents a piece of core from a depth of 40 feet to 65 feet below the surface and about 60 feet from the gossan outcrop. A few feet of pyrrhotite ore occur between 50 to 60 feet in depth, and the granite contact is not far away. Megascopically, the rock is dark gray, fine-grained, showing feldspar, hornblende and chlorite. Under the microscope, fully half the rock is seen to be made up of plagioclase, giving extinction angles of labradorite and andesine. The crystals are above the average size of those found in the older norite, but smaller than the average in the nickel-bearing norite. No unaltered pyroxene can be distinguished, but only secondary products, such as pale-coloured hornblende, uralite and chlorite, which together make up about a quarter of the rock. Pyrrhotite and pyrite in irregular grains make up most of the remainder, but no magnetite could be clearly distinguished. There are a few small crystals of apatite, and a little quartz is present intergrown with plagioclase. The origin of this rock is somewhat doubtful, but it may be an altered form of norite.

Sections 14 and 15 were taken from portions of greenstone rock, which occur as intrusions or inclusions in the Laurentian hill rising in the north of the swamp. In the field they appear as fine-grained dark greenish-gray rocks, with a few specks of pyrite and rusty iron stains on the surface. Under the microscope, both sections show plagioclase to make up about half the rock. In section 14 the extinction angles are those of labradorite and bytownite, and the shape and size of the plagioclase crystals are fairly typical of sudburite. In section 15 the extinction angles are those of labradorite and the size and characteristic features are partly like the sudburite and partly like norite. About half of No. 14 is made up of a cloudy aggregate dividing the feldspar about evenly. In this aggregate some augite and uralite may just be distinguished with a little magnetite scattered throughout. There are a few specks of pyrite, and a fragment of calcite lies on the edge of the section. The rock represented by section 14 may be derived from sudburite which has been a good deal altered and decomposed.

In section 15 about one-third of the rock is made up of pyroxene and its alteration products. This may be divided into three parts about equal in quantity: (*a*) hypersthene, (*b*) diallage, (*c*) secondary hornblende or uralite. The remainder of section 15 consists chiefly of magnetite, pyrrhotite and a very little chalcopyrite. This rock, with intermediate characteristics of plagioclase and some pyrrhotite as well as magnetite, may be derived from sudburite or norite, or it may even be a transition form between the two, due to contact and digestion of sudburite by norite.

Sections 16 and 17, like 14 and 15, are from greenstones found in the granitoid-gneiss. These rocks are much decomposed, and at present appear to be made up chiefly of plagioclase and secondary hornblende. There is also present augite, diallage, magnetite, biotite, epidote and a little quartz. They may have been derived from sudburite, but it is better not to call them anything but basic eruptives in the Laurentian.

Section 18 shows the contact line between the granite and greenstone. The rock is much altered and not worth describing.

D—Local Types, Partly Micropegmatitic

The rocks under this heading are more acid than those under headings A, B, C. The increase in the quantity of silica, while retaining some of the features of norite, may be due to a partial exchange of constituents between the norite and included masses of granite through a process of digestion, or it may be simply due to local acid excretions from the norite.

Section 19. The core from which this section was taken came from the same drill-hole as No. 10, but about 10 feet deeper, that is, at a depth of 460 feet. Section 10 showed a good example of typical norite, with much basic plagioclase and a good deal of hypersthene. In section 19 about half consists of a micrographic intergrowth of quartz and kaolinized feldspar (orthoclase and plagioclase). The remainder is made up of phenocrysts of pale green hornblende, a little diallage, some brown biotote, pyrite and magnetite. Megascopically, the rock is gray feldspathic, with feldspar, hornblende and biotite plainly visible.

Section 20 was taken from a piece of core 15 feet below the core for No. 19. The rock is finer grained than No. 19, and more decomposed. A good deal of secondary hornblende can be distinguished and there is some micrographic intergrowth of quartz and feldspar. A little biotite and magnetite is present. The rocks shown in sections 19 and 20 may be just local acid excretions from the norite eruptive.

Section 21 represents a piece of core from the same hole as Nos. 19 and 20, but at an unspecified depth. Megascopically, it is a coarse-grained rock; about half is granitic, showing pinkish feldspar and quartz; the other half is made up chiefly of hornblende. Under the microscope a little plagioclase can be distinguished as minute crystals in kaolinized feldspar. About half of the section shows hornblende with some plagioclase and quartz; the other half consists chiefly of a coarse pegmatitic intergrowth of quartz and feldspar. Some epidote is present and a little pyrrhotite and pyrite.

The rock represented by this section may be from an included mass of the Laurentian, and its peculiar features may be due to the influence of the norite eruptive in which it is enclosed.

Section 22 represents a piece of core from the same hole as Nos. 10, 19, 20, and 21, but at a depth of only 170 feet. It has somewhat the appearance of marble; is grayish-white in color, and the fracture surface shows a vitreous to pearly lustre. Under the microscope, much decomposed material appears to be made up of kaolinized feldspar with a light brown hornblende. Quartz is intergrown with some of the feldspar forming a coarse pegmatitic structure. A large portion of the section is made up of calcite. The rock appears to be a secondary product, and may be considered as vein matter in the norite.

E—Micropegmatite

Section 23 represents a piece of core from a depth of about 70 feet and about 800 feet from the outcrop. The pyrrhotite ore body is first intersected here at a depth of 600 feet. Megascopically, the rock is of medium texture, mostly gray-green in colour, but faintly pink in places. Feldspar, quartz and fibrous hornblende are plainly visible. Under the microscope, it is essentially composed of a micrographic intergrowth of quartz and feldspar, with a good deal of fibrous hornblende. The accessories are magnetite, biotite and a few little crystals of apatite. About one-third of the whole is composed of quartz, one-third of feldspar and nearly one-third of hornblende. In addition to the micrographic intergrowth, the quartz occurs as a few large fragments with small apatite inclusions. This rock represents an intermediate acid phase of the norite, which has not quite reached the stage of a typical micropegmatite.

Section 24.—The rock for this section was taken about a quarter of a mile south of the granite contact, and approaching the area of the norite acid phase. In this case, however, it is too basic for a good example of micropegmatite. Megascopically it appears as a dioritic rock of coarse-grained texture made up of about equal portions of hornblende and feldspar with a little quartz. The feldspar has a slightly pink tinge, especially on the weathered surface. Under the microscope, some of the feldspar is seen to be plagioclase, giving extinction angles of labradorite and andesine. A little quartz is present and part of it forms a micrographic intergrowth with the feldspar. About half the rock is made up of greenish-brown hornblende, and there is some sign of a little augite in a transition stage to hornblende. As accessories, a good deal of magnetite is present and a little calcite. This rock, which now has the character of diorite, may be considered as an intermediate stage between the basic and acid phases of the norite eruptive. Under the microscope it has been shown to be further removed from the true micropegmatite than the rock in section 23.

F—Laurentian, Granitoid-Gneiss, etc.

Section 25.—The core for this section comes from the same drill-hole as the cores for sections 4, 5, and 6. It was taken at a depth of 452 feet, that is to say, 2 feet lower than section No. 5, and 15 feet higher than No. 6, both of which showed the rock to be sudburite. As already mentioned under the heading of section 6, the main body of the Laurentian is penetrated by the drill-hole at a depth of 468 feet. From the evidence given by this hole and other drill-holes in the immediate neighborhood, it appears that the nickel-bearing eruptive near its contact with the Laurentian contains blocks of the older norite and of the Laurentian granite, also that tongues of the older norite penetrate the Laurentian, and both the older norite and the Laurentian have been penetrated by tongues of the nickel-bearing eruptive.

Megascopically, this rock shows a slightly gneissic structure, the hornblende being somewhat banded in the feldspar and quartz. The feldspar has a slightly pink tinge. Under the microscope, the feldspar is seen to be kaolinized and cloudy, and the quartz shows uneven extinction due to strain. About half the rock consists of feldspar and the remainder of hornblende and quartz, with a little magnetite and pyrite as accessories. The rock is evidently a piece of the Laurentian granitoid-gneiss.

Section 26 represents a piece of the lighter coloured portion of the rock taken from the surface of the Laurentian hill. Feldspar (dull white to faintly pink in color), quartz and hornblende are visible to the eye, and the rock has a slightly gneissic appearance. Under the microscope the feldspar, which makes up about half the rock, is seen to be much decomposed and appears to be chiefly orthoclase. Quartz is abundant and shows uneven extinction. There is a good deal of hornblende, but it is not well developed. A little magnetite is present and a few spots can be seen of a brownish mineral, which is perhaps limonite. This rock represents the acid phase of the Laurentian.

Section 27 represents a piece of core taken from a depth of 418 feet in a drill-hole about 400 feet from the outcrop. The ore body here lies about 50 feet higher. The core is closely speckled grayish-green, somewhat granitic in appearance, with grayish-white feldspar, green hornblende and a little epidote visible. A slight tendency to banding may be observed. Under the microscope the feldspar is seen to be much decomposed and partly altered to epidote. The feldspar appears to be chiefly orthoclase, but with some plagioclase giving extinction angles of andesine. In addition to the feldspar, hornblende and epidote which make up the rock in about equal proportions, a few small grains of titanite are present. This rock may be classified as a syenitic gneiss, and it represents a less acid phase of the Laurentian than the rocks shown in sections 25 and 26.

Section 28 represents a piece of the darker-coloured rock from the surface of the Laurentian hill. About half is made up of hornblende and the remainder is chiefly feldspar and quartz. It has a slightly gneissic structure. Under the microscope about half is shown to be hornblende. Quartz is distributed throughout, but makes up less than a quarter of the whole. Part of the quartz shows a micrographic intergrowth with the feldspar. The latter, which occurs in subordinate quantity, is much decomposed, but is apparently chiefly plagioclase. There is a very little magnetite, some of which has been altered to hematite. The rock may now be called a quartz-diorite, and is a somewhat basic phase of the Laurentian.

G—Olivene-Diabase Dike

Section 29.—This sample of rock was taken from the surface of a narrow dike which cuts the Laurentian. To the eye it is an almost black compact rock showing minute lath-shaped crystals of white feldspar. Under the microscope, about half consists of a dark glassy ground-mass and one-third of plagioclase. The plagioclase is divided into lath-shaped crystals of two periods of consolidation. The larger crystals occur as phenocrysts with other porphyritic crystals or grains of augite and olivene, which all belong to the earlier generation; the smaller crystals, those of the second generation, occur throughout the glassy base as little needles. The larger crystals show extinction angles of labradorite and bytownite, and make up the greater portion of the plagioclase. Many of these crystals contain glassy inclusions. Olivene appears to predominate over the augite, although in some cases it is not easy to determine definitely the exact mineral of the phenocrysts. A few light-brown octagonal crystals of augite can be clearly distinguished, and the olivene appears as almost colorless to faint yellowish-green crystals and grains. Part of the olivene has been altered to serpentine, and there is indication of chlorite. Some mineral grains are stained reddish-yellow, probably due to the presence of iron oxide. The olivene and augite individuals are packed in between, and wrapped round the larger crystals of plagioclase, showing a fairly well developed ophitic structure. In this section no magnetite could be distinguished, most of the iron being probably contained in the dark, glassy ground-mass.

Relationship of Sudburite to the Ore-Deposit

Probably the subject of chief general interest in the foregoing notes is that referring to the presence of sudburite in considerable extent on this part of the northern nickel range. In Dr. Coleman's report in the Bureau of Mines, 1905, page 81, he mentions the older norite as occurring in Wisner township, north of Joe's lake, but as not having been, at that time, observed elsewhere on the northern range, and I do not think there has since been any new record of its appearance in another part of the northern range. In the same report Dr. Coleman shows that the older norite (sudburite) has been proved to extend, with some interruptions, from the Gertrude mine in Creighton township easterly along the southern nickel range to the Blezard mine in Blezard township. Now, it seems to be of considerable interest to be able to show that a similar rock occurs in Levack township, which is directly opposite Creighton township, and on the north side of the basin. In this paper it has also been shown that, at Levack, the sudburite occurs at or near the margin of the nickel-bearing norite, as is the case along the southern range. This new evidence, then, tends to show a direct connection between the older norite found on the north and south sides of the basin, just as the connection between the nickel-bearing norite was established some time ago. In the same way it confirms Dr. Coleman's statement that: "It is highly probable that the lava flows, etc., of the older norite represent an earlier outbreak of material from the same general magma as supplied the nickel eruptive."

The descriptions given under the headings A and C show that the sudburite is generally found to occur near the bottom of the ore body or nickel-bearing norite, and overlying or penetrating the Laurentian granitoid-gneiss. This is, of course, a useful fact to know as a guide to exploration work, for, where the older norite is found and other conditions are favorable, then the place to look for the ore body is farther in the direction of the dip, since the nickel-bearing norite, in general, overlies the sudburite.

Points Confirming the Theory of Magmatic Segregation

It may be mentioned that the character of the ore deposits at Levack adds further confirmation to the theory of magmatic segregation, which has been so ably advocated by Dr. A. E. Barlow, Dr. A. P. Coleman, Dr. T. L. Walker and other well-known authorities. On pages 18 and 19 of his report (1905), Dr. Coleman gives seven arguments in favor of the magmatic theory, and most of the points can be plainly observed at Levack. The facts in agreement which I have noticed may be briefly stated as follows:—

1. The ore is everywhere associated with the norite eruptive.

2. Norite and ore are mixed in every degree from rock enclosing scattered particles of ore, to almost pure ore with a few rock-forming minerals scattered through it.

3. Except as included blocks or where influenced by direct contact with the nickel-bearing eruptive, the adjoining granitoid-gneiss is not spotted with ore, nor does it have separate bodies of ore enclosed in it.

4. The freshest norite is generally close to the ore bodies, and is often specked with ore. The best preserved hypersthene is found in sections containing sulphides, and not in specimens free from sulphides and at a further distance from the ore deposits. (See sections 10, 11, 12.)

5. As far as the writer has yet seen, there is little trace of the agency of water in forming the ore bodies. There is practically no vein, banding or concentric structure. No plain indication of a process of replacement was noticed in the sections showing pyrrhotite ore.

6. The character and quality of the ore body is comparatively uniform at places a considerable distance apart.

7. There is a well-defined bay in the Laurentian formation where the chief ore body outcrops, and its shape there is in the form of a trough, although it flattens out farther in the direction of the dip. These conditions conform to the theory of the ore settling in hollows under the molten sheet.

In closing I wish to express my grateful acknowledgment and thanks for the help and laboratory facilities given to me by Dr. T. L. Walker, and for the kind assistance of Dr. A. P. Coleman, with whom I discussed the sections recorded as sudburite. Dr. Coleman, of course, first discovered the presence of the older norite in the Sudbury nickel field, and he describes it fully in his report, 1905. He has lately given it the name of "sudburite," which name I have made use of in this paper.

Prefatory Note to Dr. Coleman's Paper

Dr. Coleman handed this paper in for publication on the eve of his departure from Canada for a trip of six months' duration. It has been published during his absence and he has not had an opportunity to read the proof sheets.

While Dr. Coleman's descriptions of the relations of the pre-Cambrian rocks agree, for the most part, with those by Mr. Cyril W. Knight and myself in Part 2 of the XXII Report of the Bureau of Mines, pages 122-138, his age classification of the rocks differs in some important respects from ours. We believe that Logan, in his description of the Lake Huron region, clearly intended to restrict the name Laurentian to rocks that are older than those we now call the Sudbury or Timiskaming series. Hence we would place in the Laurentian what Dr. Coleman calls "Granites Eruptive through the Keewatin," and which he classes as pre-Laurentian. To those granites and gneisses which Dr. Coleman calls "Laurentian in Eruptive Contact with Lower Rocks" we give Lawson's name Algoman.

The granites and gneisses to which Logan first applied the name Laurentian lie adjacent to the Ottawa valley, a considerable distance east of the north shore of Lake Huron. Our work in southeastern Ontario has shown that large areas of these rocks are older than a series of conglomerates and other sediments that are comparable to the Sudbury, or Timiskaming, series.

Moreover, the Sudbury, or Timiskaming, series of Lake Huron, Cloche mountains and elsewhere, as well as the rocks to which Dr. Coleman gives the name Lower Huronian, were called Huronian by Logan and Murray. They knew that some of these fragmental rocks in the region were intruded by masses of granite and gneiss, but the great unconformity between the two groups was not recognized. While we believe that Dr. Coleman's Sudbury series, or what we have called the Timiskaming, is as much entitled to the name Huronian as is the group to which Dr. Coleman applies the name Lower Huronian, we prefer, for the present at least, to drop the name Huronian for both groups and to call the lower one Sudburian or Timiskamian, and the upper one Animikean. Up to the present it has not been proved that the group called Lower Huronian or Ramsay Lake series by Dr. Coleman is different in age from the so-called Animikie of the nearby Sudbury basin. The unconformity between the Lower Huronian and the Upper Huronian of Dr. Coleman, while somewhat widespread, is comparatively slight.

Considering the great thickness of sediments in the Sudbury or Timiskaming series, it seems to us doubtful whether the period of erosion between the Keewatin-Laurentian (Granites Eruptive through the Keewatin in Dr. Coleman's table) and the Sudbury or Timiskaming series was less than that between what Dr. Coleman calls the Laurentian and his Lower Huronian. Measurements of the Sudbury or Timiskaming series are given on page 214 of Dr. Coleman's paper.

The following table will make clearer the agreements and differences between the classification of Dr. Coleman and that of Mr. Knight and myself:

	COLEMAN	MILLER & KNIGHT	
POST-LAURENTIAN	Keweenawan.	Keweenawan.	
	Discordance	*Discordance*	
	Animikie.		
	Discordance		
	Upper Huronian.	Animikean (*with small discordance*).	
	Small Discordance		
	Lower Huronian.		
	Great Discordance	*Great Discordance*	
	(Laurentian in Eruptive contact with lower rocks)	(Algoman, Eruptive.)	
PRE-LAURENTIAN	Sudbury Series.	Timiskamian.	
	Great Discordance	*Great Discordance*	
	(Granites Eruptive through the Keewatin.)	(Laurentian, Eruptive.)	
		Loganian	Grenville (*Sedimentary*)
	Keewatin, probably=Grenville Series.		Keewatin (*Igneous*)

From the Geology of Canada, 1863, it is seen that Logan applied the name Huronian to all the pre-Cambrian conglomerates and associated fragmental rocks of the north shore of Lake Huron. He recognized that certain of these sediments were intruded by granite and gneiss. But he was mistaken in assuming that all of his Huronian rocks were of one age. In other words, he did not recognize that certain conglomerates and other sediments rested on the eroded surface of the granite which was intrusive into conglomerates and quartzites.

The following quotations from Logan's classic volume will make these statements clear:

"The intrusive granite occupies a considerable area on the coast of Lake Huron, south of Lake Pakowagaming [Pakowkami.] It there breaks through and disturbs the gneiss of the Laurentian series, and forms a nucleus from which emanates a complexity of dykes, proceeding to considerable distances. As dykes of a similar character are met with intersecting the rocks of the Huronian series, the nucleus in question is supposed to be of the Huronian age, as well as the greenstone dykes which are intersected by it." (Geol. Canada, 1863, p. 58).

"On Lake Huron the rocks of this [Huronian] series occupy the coast from Shebahahnahning [Killarney] to the mouth of the Mississagui River and in the valley of the Spanish River they appear to have a breadth northward from Lacloche of about ten miles. The rock which there limits them on the north is probably a part of the Laurentian gneiss, though it has been found difficult to distinguish the gneiss in that part from an intrusive granite." (Geol. Canada, 1863, p. 61).

From these quotations it seems clear that Logan desired to restrict the name Laurentian in the Lake Huron region to those granites and gneisses that are older than the oldest conglomerates and other sediments, and that those granites that cut any of the conglomerates or other sediments should be called Huronian. But since his Huronian embraced rocks separated by a great unconformity it seems best to discontinue the use of the name, especially as the Animikie, Ramsay Lake conglomerate (Lower Huronian of Dr. Coleman) and the Cobalt series are all post-Algoman and have not been proved to differ in age.

W. G. MILLER.

THE PRE-CAMBRIAN ROCKS NORTH OF LAKE HURON

with Special Reference to the Sudbury Series

By A. P. Coleman

Introduction

The Sudbury region has long been known for its nickel deposits. These great ore bodies and the eruptive sheet of norite-micropegmatite with which they are connected have naturally attracted much attention, and their relationships have been carefully studied; but the neighboring sedimentary rocks have usually been passed over with only a brief notice, though they are really of great interest and afford the best clue to the solution of the puzzling problems of the Canadian pre-Cambrian. The Sudbury sedimentary rocks with their extension southwest to Lake Huron and west to the typical Huronian region have been traversed and briefly described by a number of geologists, beginning with Murray in 1849,[1] who canoed along the Wanapitei and other rivers which cross the region. He included the whole as either Huronian or Laurentian. Dr. Bell and his assistants were the first to prepare a map of the Sudbury district, with special reference to the nickel mines, but indicating also the adjoining sedimentary rocks.[2] Dr. T. L. Walker a few years later published a rough map of the nickel eruptive and its surrounding rocks and gave a brief description of the sedimentary beds;[3] and still later Dr. Barlow referred to them in his important report on the "Nickel and Copper Deposits of the Sudbury Mining District,"[4] but directed his attention chiefly to the eruptives. Drs. Bell and Barlow are inclined to consider most of the sedimentary rocks as really of eruptive origin, e.g. ash rocks, deposited in the sea.

In 1902 the present writer was directed by Mr. T. W. Gibson, Deputy Minister of Mines for Ontario, to begin field work in the Sudbury region, and in 1905 a map and report on "The Sudbury Nickel Field" was published by the Bureau of Mines.[5] In this report the writer followed the practice of all former students of the region in calling the sedimentary rocks at Sudbury Huronian; though he noted that they included two series separated by a great unconformity and that the lower series was upturned and penetrated by granites and gneisses always mapped as Laurentian.[6]

Logan placed the Huronian unconformably upon the Laurentian in the section given in the Atlas of 1863, and, as his description shows, considered it much younger than the Laurentian,[7] so that there was a serious difficulty involved in grouping all the sedimentary rocks of the Sudbury region as Huronian. The pre-Laurentian graywackes and quartzites near Sudbury were tilted and folded into mountains by the rise of the Laurentian batholiths, and these mountains were carved down and destroyed before the next sedimentary rock, the Ramsay lake conglomerate, was deposited. This

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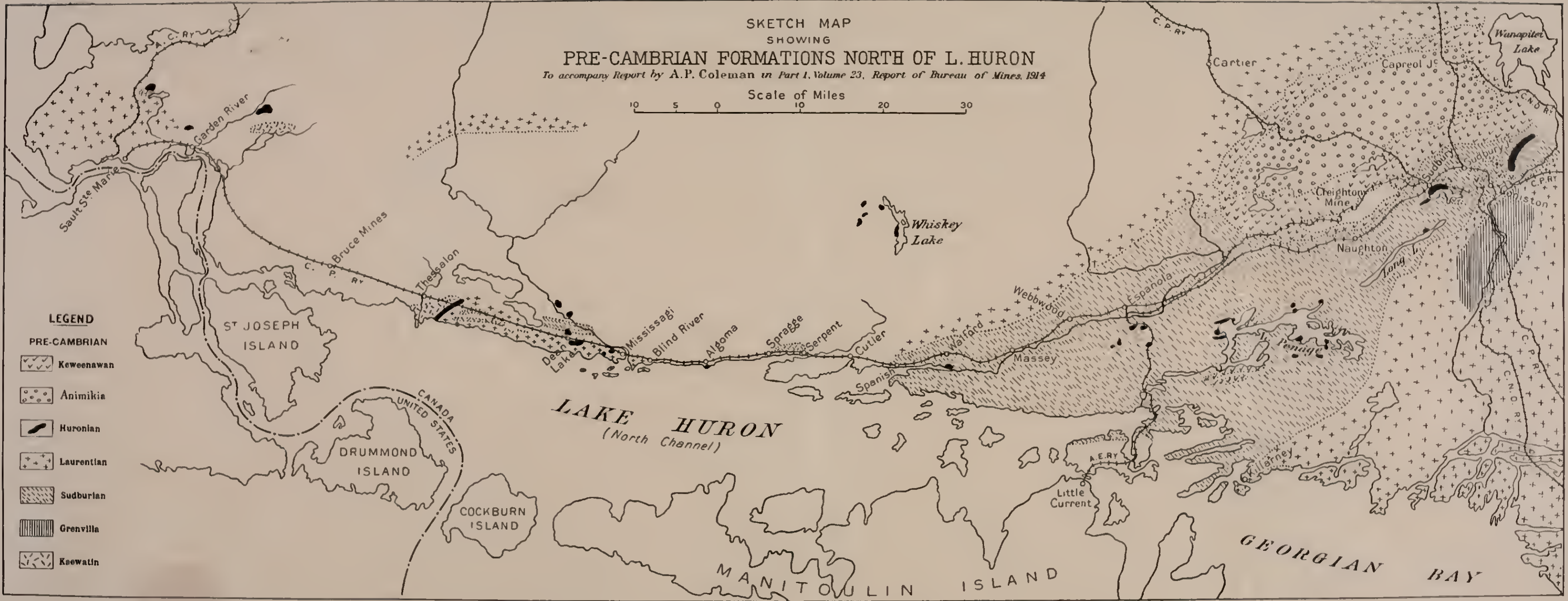
[1] Geol. Sur. Can., 1847-8, pp. 93-124.
[2] Ibid., 1890-91, F.
[3] Quar. Jour., Geol. Soc., London, Vol. LIII (1897), pp. 43-6.
[4] Geol. Sur., Can., Vol. XIV.
[5] Vol. XIV, Part III.
[6] Ibid., pp. 86-93 and 127-9.
[7] Geol. Can., p. 50. "The rock frequently exhibits the character of a compact conglomerate, holding pebbles and boulders, sometimes a foot in diameter, of the subjacent gneiss, from which they appear to be principally derived."



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[6] Ibid., pp. 86-93 and 127-9.

[7] Geol. Can., p. 50. "The rock frequently exhibits the character of a compact conglomerate, holding pebbles and boulders, sometimes a foot in diameter, of the subjacent gneiss, from which they appear to be principally derived."

is perhaps the greatest gap in the geological history of Canada and it is quite unjustifiable to include rocks below and above it in the same system. It was evident that Murray in his brief field work in the Sudbury region had confused two widely separated series under the name Huronian; and that the lower, pre-Laurentian, part should be removed as a distinct series. At first it was thought that the Sudbury rocks might be included in the Keewatin, which was known to be older than the Laurentian; but the great difference between the two groups of rocks, one consisting mainly of clastic sediments, the other mainly of volcanic materials, made this unlikely.

During the past few years while engaged in economic work in the region the problem of the correct classification of the Sudbury rocks has occupied my mind and opportunities have been taken to follow up the field relations from Ramsay lake westward to the Lower Huronian of the typical region. It has been found that basal conglomerates like those of Ramsay lake occur at thirteen points on the way to Thessalon, where the basal conglomerate of the Lower Huronian rests unconformably on the Laurentian. It can hardly be doubted that the Ramsay lake conglomerate belongs to the same horizon as the Lower Huronian, which proves that the sedimentary rocks on which these conglomerates rest are older than the Lower Huronian.

It was decided, therefore, to separate the lower rocks as a "Sudbury Series" from the rocks hitherto mapped as Huronian and to give them a position between the Huronian and the Keewatin. Before these results were published the geologists of the Bureau of Mines had been confronted with a similar problem on Lake Timiskaming, in the Porcupine region, and at other points, and had separated a Timiskaming series, penetrated by granites and covered unconformably by the Cobalt conglomerate, the relations being the same as those between the Sudbury series and the Laurentian and Huronian. Morley Wilson also had defined a Pontiac series in Quebec, which seems to occupy the same position.

Reference to older work showed that sedimentary rocks, including a thick conglomerate, and penetrated by granite and gneiss mapped as Laurentian, occur at several points in the north and west of Ontario, for instance, at Michipicoten, east of Lake Nipigon, at Heron Bay, along Seine River and near Mine Centre in the far west of the province. These sedimentary groups are younger than the Keewatin, since in many places their conglomerates enclose fragments of jasper and of green schist derived from the Keewatin, and they are in all cases older than the granitoid gneiss generally called Laurentian. In the Sudbury-Cobalt-Porcupine region these rocks are almost always steeply tilted where they underlie the comparatively flat Huronian or Cobalt basal conglomerate.

If all of the areas referred to are of the same age, as seems probable, sedimentary rocks intermediate between the Keewatin and the Huronian are widely spread and are of equal importance with the other pre-Cambrian series.

The separation of these older sediments removes many difficulties from the classification of the pre-Cambrian of Canada and should be adopted generally. As the rocks of this age near Sudbury have been somewhat long and carefully studied, occupy a large space and have an estimated thickness of more than 20,000 feet far surpassing the known area and thickness in any other region, probably the whole series may be named the Sudbury series or the Sudburian. The name Timiskaming series, given by Dr. Miller, was earlier in use;[7a] but for the reasons just given "Sudbury series" or "Sudburian" seems preferable.

In a paper prepared for the recent Geological Congress on "The Sudbury Series and its bearing on pre-Cambrian Classification," the writer has arranged the various groups of rocks found in the region, including Sudbury and the typical Huronian district as follows:

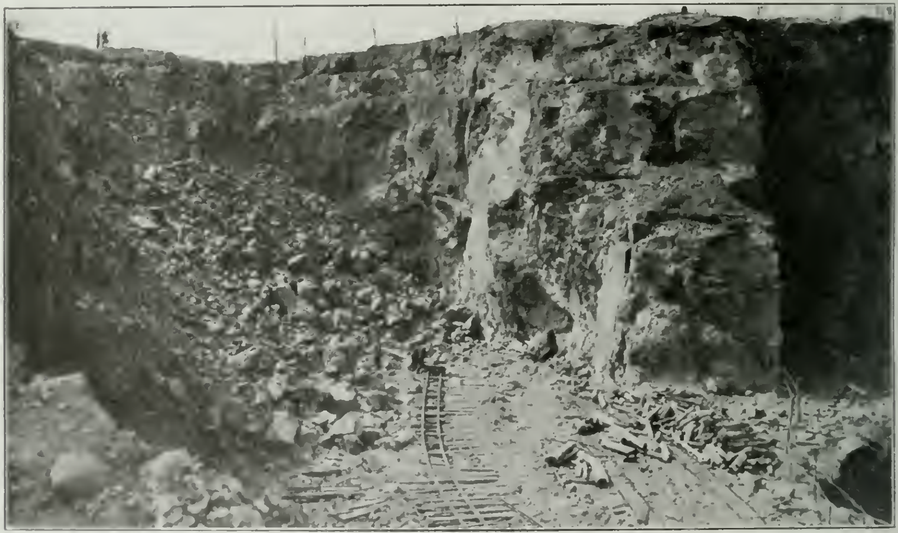
[7a] Eng. and Min. Journ., Sept. 30th, 1911, and Ontario Bureau of Mines, Vol. XIX, Part II.

POST-LAURENTIAN
Keweenawan (Mamainse, Nickel Eruptive, etc.)
Discordance
Animikie (Sediments included in the Nickel Basin).
Discordance
Upper Huronian.
Small Discordance
Lower Huronian.

Great Discordance
(Laurentian, in Eruptive Contact with Lower Rocks).

PRE-LAURENTIAN
Sudbury Series.
Great Discordance
(Granites Eruptive through the Keewatin).
Keewatin, probably=Grenville Series.

The Sudbury series, as here placed, was formed between two great periods of mountain building followed by profound erosion and is therefore separated by a great lapse of time from the Keewatin below and the Huronian above. The subdivisions will be taken up in the order of time, but the Sudbury series, as the most important new element in the classification, will be described more fully than the others.


Moose Mountain Iron Mine

The Keewatin

Keewatin rocks occur in small amounts at several places in the Huronian region, but they have attracted little attention. In 1891 Alexander Winchell found that there were older rocks included in the typical Huronian and suggested that they be called Keewatin.[8] The present writer observed bands of green and gray schist enclosed in the Laurentian gneiss east of the basal conglomerate near Thessalon in 1899 and came to the conclusion that "if these rocks were found on the Lake of the Woods there would be no hesitation in assigning them to the Keewatin."[9] As a result of the visit of the International Committee in 1904 it was recommended that the "green chloriti slate" of Logan's classification should be called the Thessalon series and should be assigned to the Keewatin.[10] There can be little doubt that most or all of the areas mapped by Logan and Murray as "green chlorite slate" represent basic lavas older than basal Huronian conglomerate and also than the Laurentian, and that they are probably equivalent to the Keewatin greenstones and pillow lavas of the west. The sedimentary type of Keewatin is represented also, by a very small outcrop of iron formation in Aweres township eight miles north of Sault Ste. Marie, taken up years ago as an iron location. Some test pits show banded silica and magnetite dipping 50° to the east. Just to the south there is Laurentian granite enclosing bands of green schist,[11] and 200 paces to the north one finds Huronian conglomerate charged mainly with Laurentian debris.

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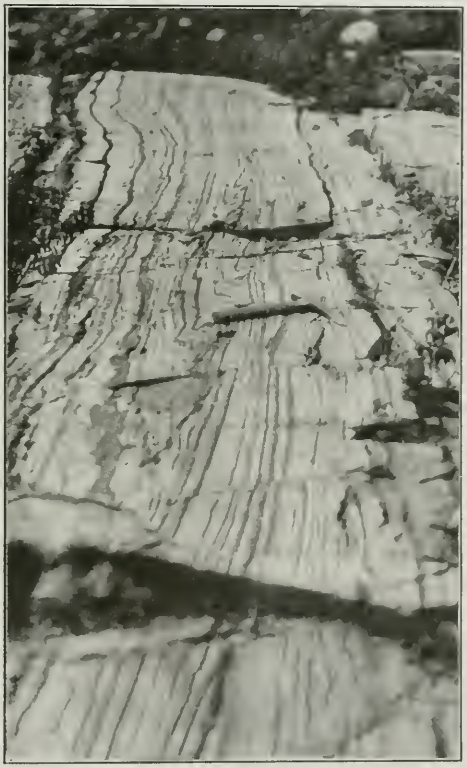
[8] Bull. Geol. Soc., Am., Vol. II, pp. 85-124.
[9] Bur. Mines, Vol. VIII, Part II, p. 163.



Keewatin Iron Formation, Moose Mountain

The most important Keewatin outcrops near the Huronian region are the bands of iron formation north of Batchawana Bay, where many years ago a good deal of stripping and other development work was done. About four miles north of the bay a band of jaspery iron formation with some pockets of hematite rises as a ridge which runs for several miles east and west. Five miles north of the Batchawana mine another belt of iron formation runs east and west on the Vulcan and Mammoth properties in Palmer township. The materials here are banded quartzite and magnetite differing totally in appearance from the rock nearer Batchawana. The relations of these Keewatin bands to the Laurentian and Huronian are not well shown, since all the lower ground is drift covered.

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[10] Jour. Geol., Vol. XIII, 1905, pp. 101-2.
[11] Bur. Mines, Vol. X, pp. 187-8.

The presence of the vast number of jasper pebbles in the Huronian jasper conglomerate indicates a still hidden outcrop of iron formation with jasper of a brighter red than that found at Batchawana.

East of the typical Huronian region no large outcrops of Keewatin are known, though numerous bands of green schist in the Laurentian may be of that age. Small strips of banded quartzite and magnetite south of Clear Lake near the northern nickel range evidently belong to the iron formation; and much more important outcrops of the Keewatin occur in Hutton township seven miles north of the northern nickel range.

It is very desirable that this Keewatin area should be mapped in detail so as to bring out its general relations to the Laurentian, which cuts it; and to the Sudbury series and also the Lower Huronian which are believed to occur near by.[12] Conglomerate and quartzite are found at various points in the township, but their exact relationships are not known. The banded silica at Moose Mountain is associated with banded schist, and in places is penetrated by gabbro and also by granite dikes coming from neighboring outcrops of Laurentian. The banded iron ore contains 36 per cent. of the metal, but it is much higher in grade, in the proximity of the gabbro, apparently a case of secondary enrichment.[13]

The Grenville Series

The exact relation of the Grenville to the Keewatin is not shown in the region here described since the two series are not found together; but Miller and Knight in their work in eastern Ontario place the Grenville just above the Keewatin with no unconformity between, the Keewatin consisting of basic lavas and the Grenville including sediments laid down upon the lava sheets.[14] This probably represents the true relationship, and the Grenville should therefore follow the Keewatin as a later sedimentary development in the same great period of time.

The Grenville series was first mentioned in the region north of Lake Huron by Dr. Bell who referred to certain well banded gneisses as sedimentary and of upper Laurentian age, resembling the Grenville series, though without the crystalline limestone usually characterizing that series. These gneisses occur on the southeast side of the band of Huronian quartzite (Sudbury series) mapped in the French River sheet.[15] Beyond this brief reference, containing no details as to the composition of the rocks, no further mention has been made of the Grenville series in the region until very recent years; though T. L. Walker described granite-kyanite gneiss near Wanapitei station in 1897, suggesting sedimentary materials in the Laurentian;[16] and the same occurrence is mentioned by Barlow.[17] The finding of a small patch of crystalline limestone north of Wanup by the present writer recalled attention to the Grenville rocks of the region, which occupy a considerable area.[18]

Recent examination of the so-called Laurentian southeast of the Sudbury region, shows that the Grenville series is really widespread, though of a character differing considerably from the series farther south and east. Crystalline limestone, the most notable rock in the region hitherto described, has been found only in one place, on the Toronto branch of the Canadian Pacific Railway, a mile and a quarter north of Wanup station. The greater part of the Grenville in this region consists of schists and gneisses, containing kyanite, sillimanite and garnet as well as the usual minerals; but toward the southern end there are considerable bands of quartzite.

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[12] Ibid., Vol. XII, pp. 318-321; also, Vol. XIII, pp. 216-221.

[13] Guide Book No. 7, Geol. Congress, pp. 35-40.

[14] Guide Book No. 6, Int. Geol. Congress, 1913, p. 56, and Part II, XXII Report. Ontario Bureau of Mines.

[15] G. S. C., Vol. IX, 1896, pp. 9-11, I.

[16] Inaug. Diss., Quar. Jour. Geol. Soc., London, Vol. LIII, p. 42.

[17] G. S. C., Vol. X, 1899, Part I, p. 161.

[18] The Nickel Industry, Mines Branch, Ottawa, 1913, p. 6.

The best section of the Grenville is to be found on the Toronto branch of the Canadian Pacific Railway going south from Romford. The quartzites of the Sudbury series are cut off by coarse granite and gneiss two miles south of the Junction with the main line of the Canadian Pacific; beyond which for about a mile only Laurentian eruptives have been observed. Then, at a quarter of a mile north of mile 118, biotite-garnet schist, with much kyanite, is found as a dark gray fresh looking rock, evidently a sedimentary member of the Grenville series and not of eruptive origin. With some interruptions of red Laurentian granite and gneiss, similar schists continue south to the crystalline limestone, which occurs a quarter of a mile south of Mile 115.

The limestone is interbedded with amphibolite and some gneiss, the whole having a width of 85 feet, of which not more than 25 feet are pure limestone. It has a strike of 30° to 50° and a dip of 44° to the southeast. It can be followed as low ridges to the southwest and northeast for about 500 feet. No attempt has been made to look for the limestone in other parts of the region.

The crystalline limestone is pale greenish gray to neutral gray in color and of medium grain. With a lens many dark green rounded particles can be seen embedded in the calcite, and thin sections disclose green augite, a little oligoclase, small amounts of some untwinned colorless silicate, perhaps scapolite, a little quartz and small grains of brown titanite. A partial analysis made by Mr. W. K. McNeill, Provincial Assayer, shows the following composition:

Calcium carbonate	74.22 per cent.
Magnesium carbonate	trace.
Alumina and ferric oxide	1.30 per cent.
Insoluble	24.20 per cent.

The limestone is too impure to be of much value. It differs entirely from the small bands of limestone found in later formations in the region, which are not crystalline, and is closely like the typical Grenville limestones of southeastern Ontario and Quebec.

The Kyanite Schists

The prevalent rock of the Grenville southeast of Sudbury is schistose or gneissoid, but differs greatly from the reddish Laurentian gneiss often interbanded with it. It is generally coarse in texture and gray or greenish gray and consists mainly of biotite, muscovite, or sometimes hornblende, quartz and plagioclase, with many crystals of pale blue kyanite and often also of garnet. Prof. Walker first called my attention to the presence of kyanite in these rocks, suggesting that the original material was clayey sandstone.

A specimen obtained a little south of the crystalline limestone has been analyzed by Mr. McNeill with the following results:

Silica	57.30 per cent.
Alumina	26.03 per cent.
Ferrous oxide	5.24 per cent.
Ferric oxide	1.39 per cent.
Lime	3.35 per cent.
Magnesia	2.03 per cent.
Potash	3.21 per cent.
Soda	1.07 per cent.
Phosphorus pentoxide	0.14 per cent.
Water	0.38 per cent.
Total	100.14 per cent.

It will be seen that in composition this rock resembles a syenite which has been weathered and leached. Syenites usually contain from 5 to 12 per cent. of potash and soda, and less than 20 per cent. of alumina; while the kyanite gneiss contains only 4.28 per cent. of the alkalies and 26.03 per cent. of alumina. It is evidently a recrystallized sedimentary rock, but differs from the Grenville gneisses described by Dr. Adams from Quebec and eastern Ontario in some important respects, containing less silica and more alumina than any shown in his analyses, and having kyanite instead of the sillimanite which he reports.[19] The reason why the silicate of alumina takes the form of kyanite instead of sillimanite is probably to be found in the relative specific gravities of the two minerals, which are 3.64 for kyanite and 3.23 for sillimanite. It may be supposed that the Grenville sediments of the Sudbury region were metamorphosed under higher pressure than those of eastern Ontario and therefore the silicate of alumina took on the denser form which is kyanite.

The kyanite gneisses begin three and a half miles north of the crystalline limestone and extend for half a mile south of it, but are lost before one reaches Wanup, halfway between miles 114 and 115, where diorite penetrated by coarse red pegmatite rises from the drift along Wanapitei river.

The Toronto branch of the Canadian Northern Railway, hitherto east of the C.P.R. branch, here crosses it and runs south to the station Quartz. Near the quartz mine, which furnishes flux for the Canadian Copper Co.'s smelter at Copper Cliff, Grenville rocks of another type show themselves—fine grained, pale brownish or gray gneisses, finely banded and quite different from the pink Laurentian gneisses and pegmatite dikes near by. They are very quartzose and contain a little microcline or orthoclase and also some plagioclase, with biotite and muscovite.

The quartzite mined is very coarse grained and glassy, mostly white, but sometimes greenish and sometimes stained red with iron oxide. In thin sections it is found to consist mainly of quartz in large, clear, interlocking portions pierced by many needles or brushes of sillimanite. There are also very small amounts of muscovite and of microcline. Sections of this quartzite are entirely different in character from sections of the Wanapitei quartzite (Sudbury series) a few miles to the north, the materials having been much more completely recrystallized.[20]

Gneisses of the Grenville character continue south from Quartz (mile 246.5 on Can. Northern Ontario Ry.), almost to the flag station Waterfall (mile 241.9), where they give way to coarse pink quartzite like that at the quartz mine, with a breadth as crossed by the railway of 370 feet. The strike is here north and south and the dip 60° to the east. The whole of this Grenville area is intersected with dikes of very coarse white pegmatite. Beyond this only Laurentian-looking rocks are seen.

The north and south section just described has a length of 9½ miles, the northern part on the Toronto branch of the Canadian Pacific, the southern part on the Canadian Northern Ontario, after the crossing of the two railways.

A parallel section a mile or less to the east is supplied by the C.N.O.R. to the north of the crossing and the C.P.R. to the south, but the northern part has proved less interesting, since no limestone has been found and the Grenville schists seem less abundant. On the C.P.R. south of the railway crossing the diorite ends a quarter of a mile beyond mile 113, and is followed by Grenville gneiss, which continues to mile 112. Just beyond this coarse quartzite, like that at the mine, occurs interbanded with gray schist, with a strike of 20° and a dip of 45° east. The width along the railway, which cuts the ridge diagonally, is 300 feet. Garnetiferous gneiss of the Grenville type continues almost to mile 111, where the railway touches a narrow lake. One hundred paces north of mile 111 and 200 paces west of the railway coarse quartzite is once more found, with a breadth of about 50 feet. There are several pegmatite dikes of white feldspar with coarse graphic structure, the whole flecked with black mica.

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[19] Am. Jour. Sc., Vol. L, 1895, pp. 67, etc.; Geol. Sur. Can., Vol. VIII, 1895, pp. 49 J., etc.: also Memoir No. 6 1910, pp. 173, etc.

[20] The Nickel Industry pp 103-4.

South of the little lake only the red-banded Laurentian gneiss with some interruptions of greenstone or diorite was found. It should be mentioned that the Grenville rocks are not continuous in the sections just given, but are penetrated by red granite and sometimes interbanded with Laurentian gneiss.

Kyanite-garnet gneiss occurs at Wanapitei, on the main line of the C.P.R., five miles northeast of the most northern outcrop of Grenville on the Toronto branch, but whether the Grenville gneisses extend farther in that direction is not known. Dr. Bell's somewhat indefinite reference to Grenville rocks in his report on the French River sheet gives the band a probable length from northeast to southwest of 30 miles. The diagonal section of 9½ miles examined by myself probably implies a width of 5 or 6 miles from northwest to southeast. It may be inferred that there is an area of 100 or 200 square miles of Grenville rocks, cut by much eruptive granite and pegmatite, in the region southeast of Sudbury. It would be rash to give an estimate of the thickness until much more detailed work has been done in the mapping of this ancient and tangled series of rocks.

Dam for Lower Power Plant, Wanapitei River

The Sudbury Series

The sedimentary rocks near the town of Sudbury, underlying in places the Ramsay Lake conglomerate, were the first to suggest that a group older than the Huronian and younger than the Keewatin or Grenville existed in the region, and as these rocks have been rather carefully studied and are extensively developed they may be described first. Three petrological divisions are naturally made in these rocks, the Copper Cliff arkose being probably at the base, followed by the McKim greywacké and the Wanapitei quartzite. No basal conglomerate has been found below the Copper Cliff arkose, perhaps because later eruptives have disturbed the relations, and it should be added that Dr. Barlow believes the arkose to be younger than the greywacké and to be enclosed by it in the axis of a syncline,[21] but the arrangement just given is more probably correct.

In the western part of the region there are considerable areas of slate, and sometimes also comparatively thick beds of conglomerate, while at a few points thin sheets of limestone may form part of the Sudbury series; but these will be referred to later, and at present only the rocks occurring near Sudbury itself will be considered.

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[21] Geol. Sur. Can., Vol. XIV, 1901, Part II, p. 65.

The Copper Cliff Arkose

Near the famous Copper Cliff mine a range of reddish hills runs from southwest to northeast, with a length of about nine miles and a greatest breadth of half a mile. They consist of fairly fresh looking material suggesting granite, and in early reports they were variously called granite, syenite or felsite. As distinct stratification is rarely seen this assumption was not unnatural. In fact, the rock is usually so massive that it is hard to determine its attitude and thickness, though it is probably steeply tilted like the well stratified greywacké which follows it to the southwest. If we assume a dip of 45°, which is almost certainly below the reality, its thickness will be about 2,000 feet. The band of arkose thins and is interrupted for a short distance just northeast of Copper Cliff, and along its northwestern edge certain greenstones appear to have encroached on its boundaries.

As a result of the coming in of these eruptives and of some granites nearby, the arkose has been a good deal recrystallized and in places long blades of green hornblende have been developed. In other places it has been brecciated, perhaps when the nickel-bearing eruptive spread out over it.

Greywacké, Sudbury Series

In thin sections one finds that the recrystallization has not gone so far as to destroy the fragmental character of the original grains of quartz and feldspar of which the rock was formed. The grains are not generally well rounded so that they cannot have been transported far by wind or water. There is scarcely any decay of the feldspars, and their fresh look suggests that the original granite weathered nearby under either desert or cold climate conditions. The old granite from which the materials came has not yet been found; but the arkose is cut in a few places by dikes of later granite, as, for example, on the hill beside the Copper Cliff mine.

The McKim Greywacké

The McKim greywacké, named for the township of which Sudbury is the centre, lies to the southeast of the arkose just described, but good contacts of the two rocks are hard to find, partly owing to the crushing and faulting caused by the nickel eruptive, so that their relations are not entirely certain. The greywacké has been much less rearranged than the arkose and presents on weathered surfaces beautiful sedimentary structures, fine stratification with small scale cross bedding and ripple marks. Its bedding is so evident that dip and strike are easily determined. The strike varies in Sudbury itself from N. 40° E. to east and west, and the dip is either vertical or 75°

to 80° to the southeast. On the hills within the town limits a width of a mile may be measured and if, as is probable, the formation continues beneath the drift toward the southeast to certain hills of greywacké near the railway station, its full width is 7,500 feet and the thickness is not less than 7,000 feet. The greywacké extends from near the southeastern corner of the nickel eruptive to Naughton, a distance of 24 miles in a direction about W.S.W.

The petrographic character of greywacké is somewhat vague; and the long belt of rock just outlined varies a good deal in composition, but always has some gritty particles of quartz and feldspar in a grey ground mass of finer material. Usually the rock is banded with finer and coarser layers, the bands varying from half an inch to two or three inches in thickness, probably an indication of seasonal changes. The finer-grained parts are slaty and usually contain pseudomorphs after staurolite, sometimes small like "rice grains," but occasionally reaching 5 or 6 inches in length, with a breadth of one inch. The pseudomorphs now consist of fine-grained quartz and sericite. In thin sections one finds in the matrix a good deal of chlorite and sericite beside obscure opaque material.

Sudbury Quartzite, with Granite to left

Near Stobie there are interesting phases of the greywacké passing into coarse conglomerate in a narrow, discontinuous band not far from the base of the formation. The pebbles include granite, quartzite, greenstone and green schist.

Where the greywacké lies beside later eruptives, as near Frood and Stobie, it is often considerably metamorphosed, even passing into schist or fine-grained gneiss. Toward the southwest, as near Victoria Mine and Worthington, the greywacké proper merges into slate and also into quartzite. One band of the quartzite at Victoria mine contains 88 per cent. of silica and was mined for use as flux in the old Mond smelter.

The greywacké has phases which connect up with arkose, slate and quartzite, and more or less greywacké is found to the southwest of the long band just described.

The Wanapitei Quartzite

To the southeast of the band of greywacké there is a still wider band of quartzite, extending as far as the Laurentian. Its contact with the McKim greywacké is commonly hidden but may be seen on an island near the western end of Ramsay lake, and there are small bands of greywacké or of slaty material in places interstratified with it. The quartzite has distinct bedding in rather thick layers and sometimes also cross bedding; and on weathered surfaces it looks like a pale grey sandstone.

In general the quartzite shows a strike of northeast and southwest, following the usual trend of the region, and has a dip averaging 45° to the southeast. Near the middle of Ramsay lake there is a suggestion of a small anticline, but elsewhere, e.g., along the main line and Toronto branch of the Canadian Pacific railway, it appears to have a monoclinal arrangement, sometimes locally disturbed by outcrops of later greenstone. As the width varies from 4 to 6 miles, the thickness can hardly be less than 15,000 feet, and may reach more than 20,000.

In undisturbed places thin sections of the quartzite show fairly well rounded grains, mostly of quartz but with a few bits of microcline or plagioclase. Usually the matrix consists of secondary quartz and sericite. The quartz often has undulatory extinction, showing strain, and there are examples where the grains have been crushed, causing a " mortar structure."

As one approaches the contact of the Laurentian there is more evidence of change, and close to the granite the materials are recrystallized into a schistose rock, which in thin sections is sometimes found to consist almost entirely of quartz arranged in thin elongated lamellæ. Where the quartzite is impure, resembling greywacké in composition, the metamorphosed rock is a gneiss with much quartz, feldspars of more than one kind, and sericite or mica.

The contact of the Laurentian is distinctly eruptive, often resulting in the *lit par lit* type of structure, where thin sheets of granite separate bed from bed, the whole being more or less completely transformed into gneiss.

The belt of quartzite just described has not yet been completely mapped. Toward the northeast it is found near Wanapitei river south of the lake, and it extends southwest at least to the Long Lake mine, a distance of more than 30 miles. It is probable that the massive quartzites of the Cloche mountains on the north shore of Lake Huron are an extension of the Wanapitei quartzite, more than doubling the length just given. Along the whole southeastern edge one finds granite or gneiss in eruptive contact with the quartzite.

Where most fully developed the members of the Sudbury series appear to have the following thicknesses:

Wanapitei quartzite	20,000 feet
McKim greywacké	7,000 feet
Copper Cliff arkose	2,000 feet
	29,000 feet

The thicknesses given must be considered approximations rather than the results of carefully determined sections. The maps of the Sudbury nickel region published by the Bureau of Mines of Ontario and the Mines Branch at Ottawa show the distribution of the sediments of the Sudbury series in the vicinity of the nickel range.

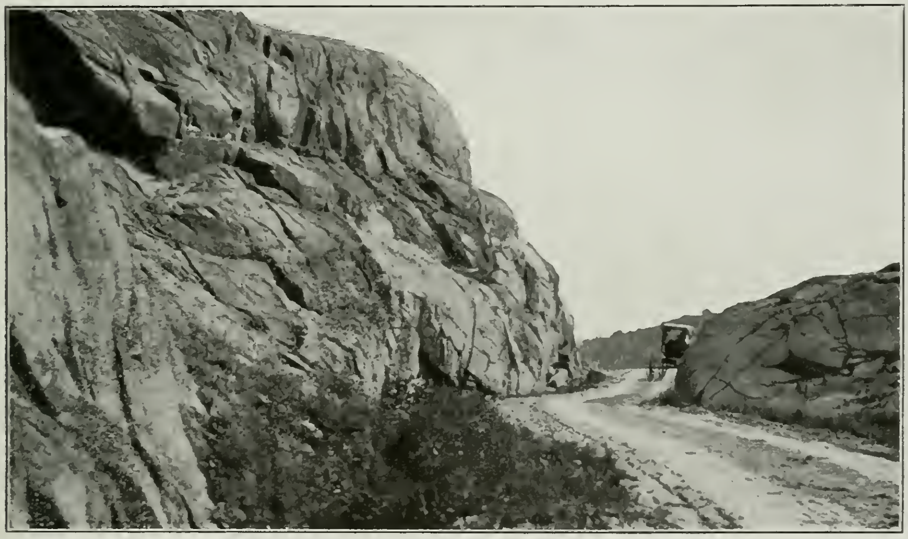
Eruptives of the Sudbury Series

Later than the sedimentary rocks just described certain bands of eruptive rocks came up as precursors of the great nickel-bearing eruptive sheet supposed to be of Keeweenawan age. These eruptives are apparently much older than the Ramsay Lake conglomerate and the Laurentian, and so may be included with the Sudbury series. Here and there among the quartzites there are a number of areas of greenstone or hornblende porphyrite, probably once belonging to the gabbro family, but, so far as studied, too much weathered to determine their orginal composition with certainty. These will not be described further.

A band of grey green gabbro, less completely transformed, runs southwest from the hills east of Sudbury to Kelley lake, a distance of nine miles, with a breadth varying from a mile to less than a quarter of a mile. The band had a laccolithic character and heaves up the greywacké on each side. The freshest portions of this gabbro are found under the microscope to consist of labradorite, enstatite and diallage, and occasionally the rock contains some pyrrhotite, suggesting a relation to the nickel-bearing norite. Curious masses of white quartz, surrounded by a hornblende albite rock, are supposed to be fragments of quartzite partly digested by the laccolith. One of these quartz masses was large enough to be mined for furnace linings at the Copper Cliff smelter.[22]

Sudburite

The most interesting of the Sudburian eruptives forms an irregular and often interrupted band along the southeast side of the nickel range, beginning at Blezard mine toward the northeast and extending to Gertrude mine on the southwest, with a length of 13 miles. Rock of the same kind is known to occur at one or two points on the northern range, and has recently been found by Mr. C. Brackenbury at the most southern of the Levack ore deposits. While not nickel-bearing itself, it seems to have been an early differentiation from the norite magma which finally spread out along the same plane and which contains the ore bodies.



Greenstone near Murray Mine, Sudbury

Where best preserved the rock is a fine-grained grey lava, with amygdaloids and pillow structure, but in many places it has been weathered to greenstone or squeezed into green schist. Thin sections of the freshest examples consist of bytownite, hypersthene and augite, with a considerable amount of magnetite. The rock contains less than 47 per cent. of silica and is distinctly more basic than the nickel-bearing norite, which contains on the average 52.77 per cent.[23] In former reports by the present writer it has been called "older norite," since its mineral composition is that of a very basic norite; but it is suggested by Dr. Miller that as an effusive or volcanic it should probably have a separate name. It may be called sudburite, for the region in which it was found, and it may be considered as having the same relation to norite as that of basalt to gabbro or rhyolite to granite. It differs from basalt in having no glass or olivine, and in the equidimensional character of its component minerals. The feldspars are very basic, bytownite as shown by their optical properties, and have usually very few twin planes, often only two, and they are never platy nor lath shaped as in the basalts and diabases. The very large amount of magnetite, 15 or 20 per cent., is a characteristic feature also, though this is sometimes found in basalts.

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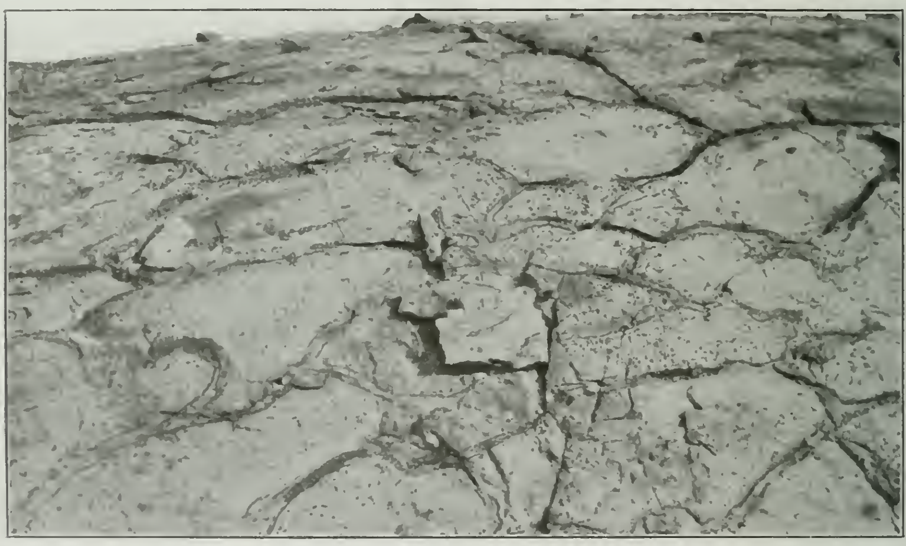
[22] Bur. Mines, Vol. XIV, Part III, pp. 121-3.
[23] The Nickel Industry, Dept. of Mines, Ottawa, 1913, p. 106.

The other dark minerals are mainly pyroxenes, more than half hypersthene (rhombic), the rest ordinary augite, the two together making up fifty per cent. of the rock. Some difficulty is met in distinguishing the two pyroxenes, since there seem to be intermediate varieties with small angles of extinction, as if hypersthene was to be considered merely augite with zero extinction angle. These intermediate forms are pleochroic. A shred or two of brown mica may sometimes be seen, suggesting a relation to the nickel-bearing norite, which generally contains biotite; but no quartz has been found in sudburite.

There are also porphyritic varieties of sudburite with large crystals of hypersthene, augite or hornblende of a poikilitic kind enclosed in the fine-grained mass. It is uncertain whether the hornblende is original or not in these porphyrites, but in many cases the sudburite may be found passing into amphibolite by weathering.

The rock found by Mr. Brackenbury, a paper by whom is published in this volume, on the northern nickel range is closely like the typical sudburite of the southern range, except that monoclinic pyroxene is present in larger amounts than the rhombic variety.



Pillow Lava, Sudburite, Elsie Mine, Sudbury

Two analyses of sudburite have been made, with results as follows:

	I	II
Silica	46.69	46.86
Alumina	14.23	16.94
Ferrous oxide	12.82	15.49
Ferric oxide	2.00	4.18
Lime	13.32	9.65
Magnesia	8.15	2.94
Phosphorus pentoxide	0.19	0.28
Titanium oxide	1.28	1.54
Potash		0.23
Soda	0.98	1.51
Manganese oxide	0.11	
Sulphur	0.12	0.09
Water	0.08	0.47
	99.97	100.18
Specific gravity	3.24	

Specimen No. I is from a hill south of Murray mine, the analysis having been made by Mr. J. A. Horton in the Applied Science Department, University of Toronto; and Specimen No. II is from south of Blezard mine, about four miles to the northeast, the analysis by Mr. W. K. McNeill, Provincial Assayer, Toronto. In silica contents the two analyses are closely alike, but there are somewhat marked differences in the alkaline earths and alkalies, the rock from Murray mine having more lime and magnesia and less soda than that from Blezard mine. It is probable that the feldspar in the latter case approaches labradorite a little more closely than in No. I.

Thin sections of the rock from Murray mine are a little fresher and are probably more typical than those from Blezard mine.

The Long Lake Region

The Wanapitei quartzite extends southwest from the region just described to Long lake, and is crossed by the road from Sudbury to the eastern end of the lake. Going south from the brickyard between Sudbury and Copper Cliff one crosses greywacké of the type previously described, a narrow band of conglomerate, no doubt basal Huronian like that of Ramsay lake, and then quartzite with a few bosses of greenstone to the end of the lake. The direction of strike is about northeast and southwest and the dips recorded are high.

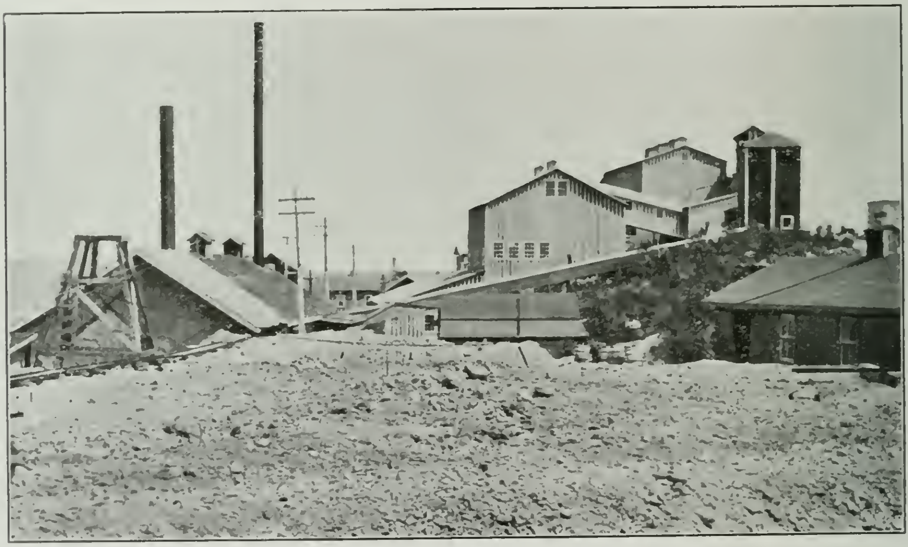
Long Lake Shaft House

Long lake is a narrow body of water nine miles in length running northeast and southwest parallel to the prevalent strike of the rocks. Its southeast shore and most of the islands in the lake are of quartzite, but there is more variety in the rocks on the northwest shore. Greenstone appears near the head of the lake and continues for three fourths of a mile, after which quartzite reappears for half a mile, followed once more by greenstone. The top of a hill, whose base is of the greenstone, is formed of greywacké conglomerate like that of Ramsay lake. Beyond this most of the northwest shore to the outlet of Long lake is of quartzite, though slate forms a low point about one-third of the way down, passing into arkose. The slate seems to underlie the quartzite, and does not correspond to the other rocks in strike, but is nearly at right angles to the usual direction (strike 140°, dip 40° to the W.). Some greenstone appears on the northwest shore before the narrows leading to the lake expansion near Long Lake mine, but the rest of the shore is mainly quartzite.

In general the rocks are much the same on Long lake as in the Sudbury section and evidently belong to the same series, with the exception of the greywacké conglomerate, which is probably Huronian.

Long Lake Gold Mine

A wagon road leads south from Naughton on the Sault railway, eleven miles west of Sudbury, to the Long Lake mine, a distance of about nine miles, rounding the southwest end of the lake and going a mile or two south of it. The rocks traversed as far as Long lake are quartzite, penetrated in places by greenstone, like those nearer Sudbury, and require no description. On the south side of the expanded end of the lake some slate shows itself and the rocks are much crushed and disturbed. On the road south of the lake the quartzite is still more disturbed, and is cut by dikes of coarse-grained and also of fine-grained diorite. Presently one observes that large blocks of the quartzite are enclosed in the diorite and are somewhat metamorphosed and penetrated by many small quartz veins. The mine itself is on such a mass of quartzite, a large irregular block enclosed in the diorite, part of it still showing bedding and cross bedding. In thin sections of the ore one finds the quartz crushed and rolled out and accompanied by some plagioclase, the whole evidently a good deal recrystallised, since no original grains can be seen.



Long Lake Mill

The diorite is rather dark greenish-grey and consists mainly of plagioclase and hornblende, with some biotite, epidote and apatite. It is much fresher than the greenstone, rising as bosses through the quartzite elsewhere. The diorite near the mine varies considerably in character and has phases of a reddish color suggesting syenite.

Other masses and hills of quartzite, enclosed with diorite and syenitic-looking rock, occur for a mile to the south, where the eruptive has the appearance of Laurentian granitoid gneiss. Going east along the pole line which brings power from Wanapitei river well stratified and cross-bedded quartzite is seen for some distance, having the usual strike of 50° with a vertical dip, but at a mile and a half the strike has changed to 120° with a dip of 60° to the northeast, and a little beyond the strike is 150° with vertical dip showing the disturbance caused by the eruption of the Laurentian. Dikes of granite appear, and the quartzite is strongly metamorphosed, while a patch of greywacké is greatly squeezed and crumpled. At Wavy lake, about three miles east of the mine, only small patches of greatly attacked quartzite remain and the coarse red granite and gneiss are characteristically Lurentian in look. The contact is typically eruptive.

The ore of the Long Lake mine is of an unusual character, consisting simply of the quartzite impregnated with mispickel, and in part also with pyrite. The mispickel is seldom in crystals visible to the eye, but is often diffused in small particles, giving a bluish tinge to the quartz. Under the microscope these dark grey particles of mispickel can be seen irregularly scattered through the quartz. The gold, which is very fine and seldom visible, is associated with the mispickel rather than the pyrite.

There are other large blocks of quartzite enclosed in diorite nearby, but they have not proved to be gold bearing.

The Long Lake mine is owned by the Canadian Exploration Company, with Mr. R. W. Brigstocke as manager, Mr. G. E. Cole as mine superintendent, and Mr. G. W. Bissett as mill superintendent. At the time of my first visit, in July, 1912, the shaft had a depth of 200 feet, and a mill had been erected and used for testing purposes, but work was shut down until electric power should be available. A power plant was then being installed on Wanapitei river and a pole line was under construction for transmission. On my second visit, a year later, the mine and mill were in operation. The original ten stamps had been increased to twenty, and the whole of the pulp was passed through the tube mills and cyanided. It was stated that eighty tons of ore were treated in the twenty-four hours, and that from $8.00 to $11.00 worth of gold was recovered per ton, the whole of it by cyanidation. The somewhat elaborate process, in which cyanide solution began its work in the stamp batteries and continued it through the tube mills and tanks, seemed to be working satisfactorily.

The source of the gold in this unusual variety of ore is probably to be sought in the diorite which shattered and carried off blocks of the quartzite, while magmatic solutions introduced silica, compounds of arsenic and sulphur and also gold. These materials were deposited in the small fissures and also in the pore spaces of the original sandstone which became transformed to the compact quartzite or arkose which now forms the ore. If the diorite introduced the ore one would expect that other masses of quartzite surrounded by diorite, would also prove to be gold bearing, but none have yet proved auriferous.

The relation of the diorite to the Laurentian granite is not certain, though the two seem more or less to blend toward the south and east of the mine. It is likely that the diorite is younger than the greenstone bosses in the quartzite to the north and of the same age as the Laurentian. If this is correct it might be of interest to look for other basic phases of the granite along the contact with the quartzite of the Sudbury series.

Extensions of the Sudbury Series to the Southwest and West

The Region of Lake Penage

The present writer has studied the westward and southwestward extension of the Sudbury series along three routes, that of lake Penage, etc., to the southwest of Long lake, that of the Algoma Eastern Railway south of Espanola, and that of the Sault branch of the Canadian Pacific extending to the original Huronian. The region of lake Penage may be taken first. For this the maps prepared by Dr. Bell are useful.[24] A creek flowing from the west end of Long lake passes into Round lake mostly through low ground, though some quartzite appears on its shores, while all the north shore of the lake is of the same rock. At the southeast corner of Round lake, where a narrow bay extends eastwards, conglomerate occurs enclosing pebbles of granite, quartzite and dark grey slate or schist. The conglomerate becomes more and more squeezed and rolled out as one advances east in the bay until even the granite boulders are flattened and the rock becomes schist conglomerate. This probably belongs to the Sudbury series, though that cannot be considered certain at present.

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[24] G. S. C., 1890-91, Sudbury Sheet, Map 18, and 1897, French River Sheet.

The outlet of Round lake southwestwards is over greenstone into a creek winding through marshes for a mile, greenstone still showing to the north, while quartzite forms the shore of a small unnamed lake into which it opens. A half mile of creek, showing no rock, leads into the large and tangled body of water named on the oldest maps Lake Penage, on Dr. Bell's map Panache. I was informed by residents that the earlier name is the correct one.

Lake Penage extends fourteen miles from the inlet to its outlet toward the southwest, but a long and wide bay stretches also for nine or ten miles to the southeast. The shore is varied by many peninsulas, and islands of all sizes break the wider parts of the lake. Following the north shore westwards for half a mile the rock exposed is conglomerate, probably Huronian, with a matrix of dark quartzitic material enclosing boulders of granite and quartzite. Quartzite with greenstone bosses extends from this to the northward bay, from which a wagon road leads to Whitefish on the Sault branch. Here some quartzite is found on each side of the bay; but conglomerate like that of Ramsay lake caps a hill two miles inland a little to the west of the road. On the west side of the bay there is schist conglomerate, probaby of Sudburian age, so that two conglomerates exist separated by a great lapse of time.

A rugged promontory of greenstone projects southwestwards from the north shore a mile west of the road, penetrating quartzite which forms the shore of a bay to the north; while the west end of lake Penage presents a variety of rocks, including limestone, overlying a conglomerate containing few pebbles. Part of the limestone looks much like the Huronian limestone of Echo lake, though other parts are slaty. This forms the shore for a mile and a half before quartzite once more appears at the northwest end of the lake. At the extreme west end more limestone appears, some of it quite pure, so that one of the canoemen compared it to that of Haileybury (Silurian). To the south is conglomerate, whose relations to the limestone are uncertain. In all there are several miles of shore formed of limestone and the accompanying slate, and the outcrops are in places half a mile wide. The attitude of these rocks is not always certain, some parts having a dip as high as 45°, while others seem nearly horizontal. The limestone and conglomerate, with associated slate, appear to be Huronian. A partial analysis of limestone from the northeast shore of lake Penage, made by Mr. McNeill, shows the following composition:

Calcium carbonate	61.85	per cent.
Magnesium carbonate	2.32	"
Alumina and ferric oxide	2.50	"
Insoluble	33.00	"

The south side of lake Penage was less carefully coasted, but the shore and islands consist mainly of quartzite cut by bosses and bands of greenstone, probably belonging to the Sudbury series. At a few points in the southern bays slate is found, and not far from it conglomerate. Impure limestone was seen near Bedard's gold claim, a half mile west of the boundary line between townships 83 and 75. It is within 75, and near the southern side of the township. The supposed ore body is on a point including some quartzite and spotted slate, as well as the limestone. The dump obtained from a test pit shows mispickel, pyrite, pyrrhotite and chalcopyrite, but no gold was seen. The relationships are very different from those at the Long Lake mine, where quartzite and diorite are the country rocks.

In general the shores of Penage lake consist of quartzite and greenstone of the Sudbury series, but at its west end and at a few points on the south limestone, probably Huronian, is found, and at several points conglomerate occurs, probably the basal Huronian.

Lakes to the South of Penage

A short river channel with a drop of six feet leads to Walker lake, as it is named by Dr. Bell. The outlet is over a low part of a ridge of greenstone, and the shores of the lake are mainly formed of quartzite, cross bedded and sometimes containing small bands of slaty material. After a narrows at the south side of Walker lake there is a small expansion of Whitefish river and then another narrows on the east leads into Bear lake. This is surrounded mainly by Sudburian quartzite including slaty layers and also narrow belts of conglomerate, the latter enclosing pebbles of quartzite, slate, black chert and limestone as well as the never failing granite. The limestone pebbles are mostly weathered out. The conglomerate rests on quartzite at one place on the north shore as one enters the lake, but in other places it seems to be interbedded with the quartzite, and its age is uncertain. At one point it has a strike of 75° and dip of 40° to the southeast, conforming to the general arrangement of the Sudburian rocks; but the limestone and quartzite pebbles suggest a post-Sudburian age unless there are rocks of this kind contained in unknown outcrops of the Keewatin or Grenville series in the region.

A lumber road to the north of the east end of Bear lake leading towards a bay of Lake Penage shows only drift except a few outcrops of greenstone.

An excursion two miles south from Bear lake to the Cloche mountains crossed the strike of the formations and showed greenstone, slate, conglomerate, slate and quartzite. There are four ridges and four depressions occupied by streams or narrow lakes before the foot of the range is reached. The mountains are formed of pure quartzite almost as white as snow where forest fires have burnt off the vegetation. The forms are rugged with steep cliffs and large, angular talus blocks at their foot. The summit climbed reached 700 feet by aneroid above Bear lake or about 1,700 feet above the sea. It was one of the highest points in the northern ridge and was separated by a narrow and deep east and west valley from a parallel ridge near Georgian bay.

Some large blocks of vitrophyre tuff like the Onaping tuff of the Animikie at Sudbury lie on the south shore of Bear lake, but the rock was not found in place. They may have been transported by ice from some outcrop beneath the waters of the lake.

Section on the Algoma Eastern Railway

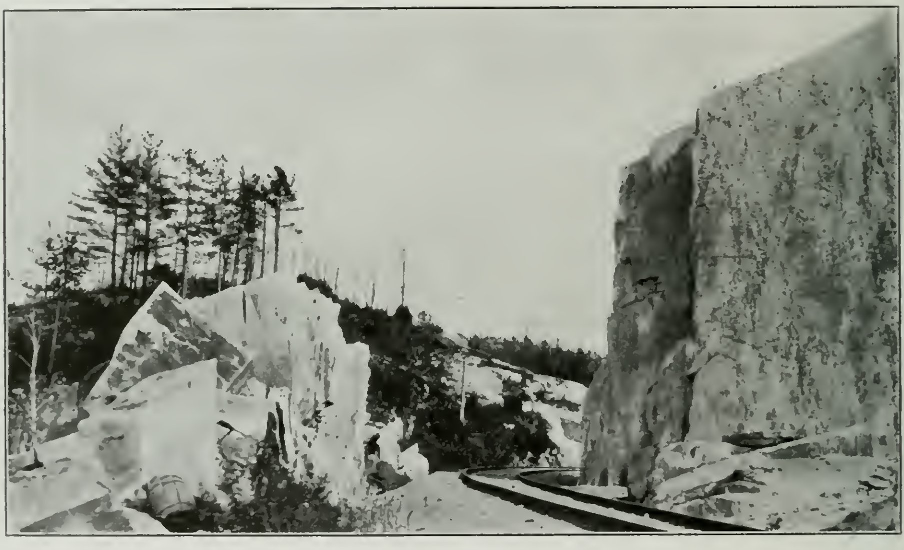
South of Espanola

The recently constructed branch of the Algoma Eastern railway running south from Espanola to Little Current provides the best cross section of the Sudbury series west of the Toronto branch of the Canadian Pacific. Just south of Espanola station on the Sault branch and between it and the village an east and west ridge of quartzite with a few included pebbles and boulders is of uncertain age. It shows no distinct stratification and may be a quartzitic phase of the Huronian. At the Falls of Spanish river which supplies power for the pulp mill coarse diorite is to be seen. For three miles south of Espanola the railway crosses a sand plain, then bends to the east to pass round a striking cliff of rock, which here consists of greenstone. One hundred and fifty paces to the east near mile 50 the cliff is found to consist of quartzite capped unconformably by a sheet of conglomerate, which can be followed for 630 paces eastwards. The quartzite has a strike of 65° and a dip of 40° to the southeast. In most places the surface is irregular as it passes under the conglomerate forming the plateau-like top of the hill, but at one point the conglomerate rests on a smooth surface of quartzite dipping 15° W.S.W. The conglomerate is like that of Ramsay lake and is probably the basal tillite of the Huronian. It must cover a large area since it is found once more on a hill top about a mile to the west of the bend of the railway.

Continuing eastwards on the railway a large dike of some basic eruptive is followed for a quarter of a mile, when quartzite appears again, having a strike of 80° and a dip of 70° to the south at mile 51. Conglomerate is exposed for the next quarter of a mile and then some impure limestone with slate and interbedded conglomerate for half a mile, all probably of Huronian age. Farther to the south quartzite interbedded with green schist and some slate extends to mile 56, beyond which there is half a mile of conglomerate resembling tillite, probably belonging to the Huronian. From this to mile 63 quartzite predominates, some green schist and slate and one or two bands of conglomerate being interbedded with it, the whole having rather high dips, occasionally reaching the vertical. They are all supposed to be Sudburian in age.

Quartzite of the same character with less of the other rocks interbedded extends from this point to Whitefish river near its exit into the Bay of Islands on Lake Huron. The last two and three quarter miles are through steep ridges of white quartzite, the westward extension of the Cloche mountains mentioned in the section south of Bear lake.

Here the railway bends southwest and passes through varied rocks, mainly quartzite, but including arkose or greywacké, and green slaty schist, all steeply tilted and penetrated by dikes and masses of diabase. Beyond mile 67 there is a band of conglomerate interbedded with slaty rock 400 paces wide, with a vertical dip in one place, though elsewhere the bedding is uncertain. The matrix is dark green and encloses gray and red granite pebbles, no quartzite pebbles having been observed. The conglomerate is thought to belong to the Sudbury series. Farther to the southwest as far as mile 72, where Ordovician sediments begin, the rocks are mainly quartzite and reddish arkose with steep dips, penetrated by masses of greenstone.



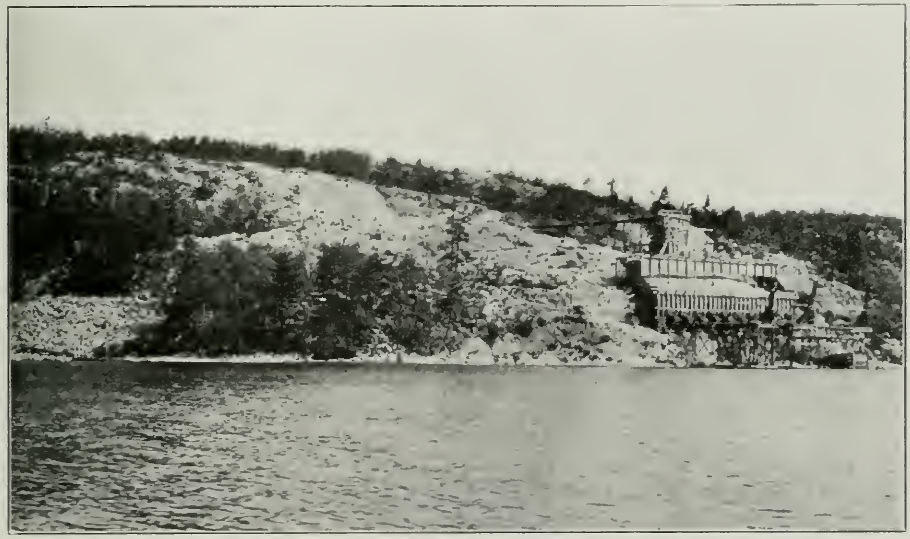
Quartzite near Whitefish, A. E. Railway

Some large boulders of vitrophyre tuff were found a little beyond this, but none of the rock was observed in place. This point is 13 miles southwest of Bear lake where similar boulders occur; and 30 miles southwest of the Onaping tuff of the Sudbury nickel basin.

Rocks Near Killarney

The quartzites north of Lake Huron are mapped by Dr. Bell as a canoe-shaped trough with the two sides converging four miles and a half east of the mouth of Whitefish river. Between the two converging belts of hills called the Cloche mountains there is low ground occupied by varied rocks of lower hardness, partly quartzite and partly arkose, greywacké, green schist and conglomerate. The shore of Lake Huron is here fringed with innumerable peninsulas and islands separated by narrow channels, one of them passing Swift Current and leading eastwards to the north end of Georgian Bay. The southern branch of the Cloche mountains runs southwest from its junction with the east and west range previously described and forks into three long, narrow and high peninsulas. Lansdowne channel separates the southern fork from some ridge-like islands and provides a route from the village of Swift Current to Killarney.

Killarney bay seems to have been hollowed out of the softer Sudburian rocks, the resistant quartzites rising as ridges above it. At the northeast end of the bay on the southwest side, coarse and also fine grained red granite lies at the foot of a steep hill of quartzite having an eruptive contact with schist and greywacké fringing the bottom of the hill. The granite which encloses fragments of these rocks is part of what Dr. Bell calls the Killarney belt, which he represents, no doubt correctly, as later than the quartzites. He states that toward each side "the grain of the rock begins to assume a sort of parallelism or a gneissoid structure," but he seems inclined to keep it separate from the Laurentian, probably because he believed the Laurentian to be older than the Huronian. He accounts for the picking up of fragments by the granite as the result of faulting, and considers the contact as due to a great fault along the southeast side of the region here described as belonging to the Sudbury series.[25] With our present knowledge of the eruptive relation of the Laurentian to the Sudbury series it is more natural to include the Killarney granite with the Laurentian.



Quartzite Quarry, near Killarney

The quartzite of this branch of the Cloche mountains rises 860 feet above Lake Huron (aneroid) or about 1440 feet above the sea, giving a magnificent view of the bays and islands. On the highest point the quartzite strikes about east and west with a dip of 70° north, which accords with Dr. Bell's idea of a synclinal arrangement. The quartzite is white and appears to be extremely pure. On the northwest shore of Killarney bay it is being quarried and shipped to Welland for use in making ferro-silicon. Mr. R. Turnbull of Welland, Ont., states that the quartzite runs from 98 to 99 per cent. silica, and that Electric Metals Co., Limited, received about 12,000 tons in 1913. The quarry is owned by Mr. A. B. Willmott, Toronto. But for the expense of crushing this very pure silica should be useful in glass making.

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[25] G. S. C., Vol. IX, 1896, pp. 6-9, I.

It is stated that the Canadian Copper Co. have taken up a large area of quartzite for flux near Whitefish river on the northern ridge of the syncline, which seems equally pure. The amount of this quartzite is to be measured by the cubic mile, so that it may be considered inexhaustible.

Quartzite Quarry, near Killarney

Gold Prospects Near the Outlet of Whitefish River

Several locations have been taken up for gold near the mouth of Whitefish river in the belt of quartzites just referred to as forming the northern range of hills. They are mainly along Howery creek and Charlton lake a few miles to the east of the railway, and the country rock is either quartzite or slate, penetrated in places by gabbro. The stratified rocks strike about east and west and have a vertical dip, and the quartz veins are in general parallel to the strike.

On the Murdock location (in Timber berth No. 11) a band of rusty quartz six feet wide has been stripped for 25 yards and a shallow pit has been sunk upon the deposit. Pyrite occurs and the rock is said to assay $12.00 per ton in gold. At Miller bay, half a mile to the south, there is a vein five feet wide containing a good deal of mispickel, and the ore is said to run $9.00 per ton. The country rock is greenish quartzite, with slate to the south. The Lehay location a mile and a half east of the one just mentioned is on the north bank of Howery creek, the vein occurring on top of a steep range of quartzite rising 190 feet above the water. There are many small veins and stringers of rusty quartz in the quartzite, said to have yielded free gold. It is of interest to find mispickel in these ores contained in quartzite 30 miles south of west from Long Lake mine, though no definite relations to an eruptive rock were found unless the gabbro mass on the Murdock location is the source of the ore.

Westward Extension of the Sudbury Series Along the Sault Railway

The sedimentary rocks of the Sudbury series have a general strike of about 70° east of north and west of south; and this influences all the physical features of the region so that rivers, lakes and valleys and often also roads and railways trend in the same direction. On that account the Sault branch of the Canadian Pacific railway provides no good sections and shows much less variety of rocks than the routes just described. There are, however, certain interesting changes to be noted as one goes west, especially the increasing metamorphism of the sediments as one approaches the northern contact of the Laurentian; and the relationship of the Sudbury series to the Huronian can, of course, be solved only by following it up to the typical Huronian region.

The Sudbury rocks continue without great change along the southern nickel range to Worthington and farther west, and need no detailed description. Except for a larger amount of slate they differ little from those already described. When one passes Espanola, south of which the last section was worked out, one finds the slate transformed to phyllite, interbedded with quartzite, and what were impure sandstones are changed to quartz mica schist with a surface glistening in the sun, only the purer sandstones retaining the appearance of quartzite. The quartz mica schist rises as steep ridges north of Webbwood, with purer pale greenish quartzite beyond, followed by the schistose variety at the old Shakespeare gold mine.

The quartz schist at Shakespeare mine drops suddenly toward the north to a valley floored with drift, beyond which rises a range of red granite hills with summits reaching 330 feet above the valley. The granite is coarse grained and not gneissoid, though it contains masses of greenstone and is penetrated by numerous pegmatite dikes. The actual contact of the granite with the Sudbury series is hidden beneath the drift.

View over Georgian Bay from Top of Cloche Mountains

Going farther west the schistose character of the sediments is more pronounced near Massey and Walford, and there are places where the Laurentian is found in eruptive contact with the quartz schist, as near the Massey copper mine.[26] Some of the mica schists here are finely and uniformly crumpled. At Walford the glistening mica schist encloses garnets and knotty looking masses of epidote. The rock consists of mucovite and biotite with an equal amount of completely recrystallized quartz. There are bands of green hornblende schist enclosed in the mica schist probably representing the rearrangement of the basic dikes. If these were found in other surroundings they would be considered Keewatin. All the rocks are steeply tilted and highly metamorphosed by the neighboring Laurentian or by a broad dike of coarse granite which cuts the quartz mica schists.

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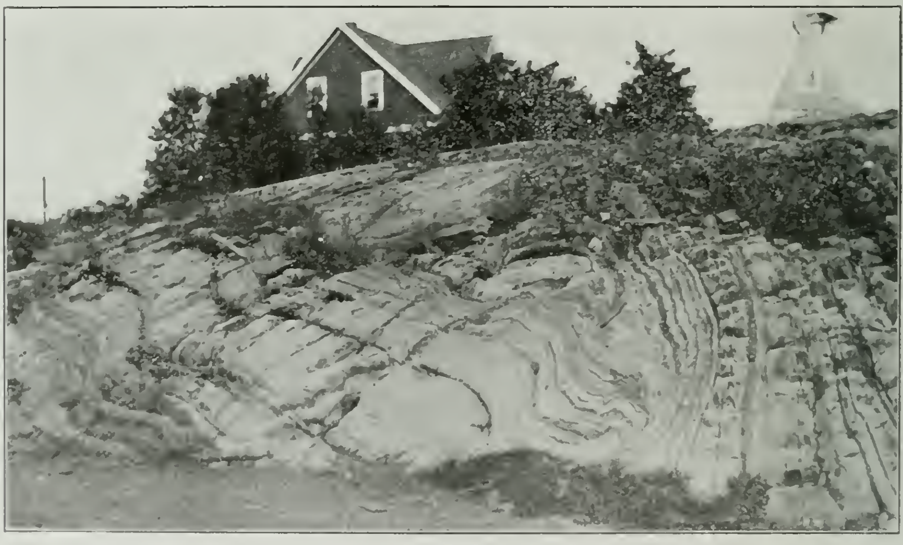
[26] Details may be found in reports on the Massey and Hermina mines, Bur. Mines, Vol. XXIII, Part I, pp. 155-9.

Following the railway west to Spanish, the next village, at the mouth of Spanish river, there is not much change in the rocks, but a road north from the village shows hornblende schist and mica schist resembling gneiss as the Laurentian contact is approached. Three quarters of a mile north there are a few pegmatite veins in the schist, and 100 yards beyond this contorted bands of schist are found entangled in coarse granite.

At the next station, Cutler, on the north shore of Lake Huron, there are large masses of quartzite showing stratification but greatly bent and folded and cut by dikes of granite and pegmatite. The quartzite must have been more nearly pure quartz than the rock which formed the schists to the east, some of which look much like the western Couchiching. A mile or two west of Cutler, near the flag station Kenabutch, the sediments have almost entirely foundered in the Laurentian magma forming a well banded gneiss, but four miles west a large mass of schist in the typical Laurentian has one part much metamorphosed, while another part still retains its stratification and even pseudomorphs after staurolite. The original rock must have been greywacké.



Sudbury Quartzite and Schist, near Granite, Cutler

At Serpent river the schists occur once more without granite, but toward the north are interrupted in places by greenstone or diorite. Two miles beyond there is gray chloritic slate with the normal strike of 70° and a vertical dip, but half a mile to the west this becomes more schistose and passes into green schist like certain Keewatin rocks of the west. This continues for a mile beyond Spragge, the next station, when it is followed by slate and quartzite or arkose containing pebbles of granite. The relations here are uncertain, and it is possible that these rocks may be Huronian, since they seem unlike the Sudbury series. The fact that they stand nearly vertical is, however, against placing them in the Huronian. Similar rocks of uncertain age, sometimes including gray and red slate and occasionally forming a conglomerate crowded with boulders of granite, extend to within a mile of Algoma.

To the north of the railway at this village, gray, well stratified and cross bedded quartzite is found, having a strike of 70° and a dip of 75° to the southeast, closely resembling the Sudbury quartzite. A little to the south of the railway there is a small exposure of conglomerate, like that of Ramsay lake, enclosing pebbles and boulders of granite, gneiss, quartzite, slate and some rusty weathering carbonate. The matrix is of greywacké and the pebbles are angular, subangular or rounded as in tillite. Unfortunately the relations between this tillite and the steeply tilted quartzite to the north are not certain. For a few feet near a bridge the two rocks come together, but the contact seems vertical and may be due to faulting. Along the trunk road running west the almost vertical quartzite can be followed for half a mile, in some places with a width of more than 1,000 feet; and a mile and a half along the railway one finds a similar quartzite with some green slate layers and in one place a few inches of banded white and black chert, suggesting iron formation.

After a short interruption, covered with drift, chloritic slate or schist appears to the south of the railway and conglomerate to the north, the latter slaty with granite pebbles. From this point to Blind river there is much drift with but few outcrops of rock, mostly quartzite steeply tilted and cut by greenstone. Two miles east of Blind river a little pink quartzite or arkose is seen and in the village there is massively bedded gray quartzite with a strike of 65° and a dip of 60° to the southeast. Thus far the rocks, except the conglomerates, have quite the character of the Sudbury series, and continue persistently the strike of about 70° and the steep or vertical dip. This brings us to the area mapped by Murray as Lower Slate Conglomerate.

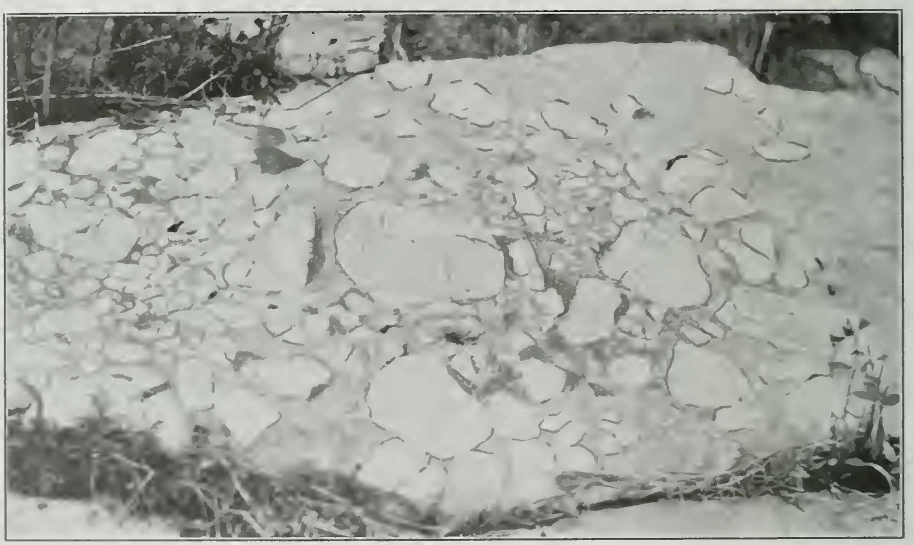
In the western part of the village of Blind River there is an outcrop of white quartzite, very different from the gray well stratified quartzites thus far described. No stratification was noted, though the quartzite contains some black chert pebbles. Unfortunately for some distance west the railway runs through drift and greenstone, with only one or two small outcrops of white quartzite having uncertain stratification. Five miles west of Blind River, after passing Mississagi river, there is greatly squeezed conglomerate for 150 paces, and then drift again, followed by red granite or syenite, mapped by Murray as Laurentian.

Relations to the Laurentian

From the notes just given it will be seen that the area represented as Lower Slate Conglomerate west of Blind river is far from being continuous conglomerate. To test the matter further some field work was done near Dean lake, where good roads lead to settlements inland. Between Mississagi river and Dean lake the railway passes a variety of rocks, in addition to the granite just mentioned. West of mile 61 (from Webbwood, the divisional point), reddish gray fine-grained arkose occurs, striking southeast and with a dip of 30° to the southwest, differing greatly from the steeply dipping quartzites, with a strike of 70° farther to the east. To the south there is slate and then drift, followed by granite. At mile 63 there is slate with the same strike but nearly vertical dip; and three-quarters of a mile beyond a slaty rock, containing a few pebbles of granite. A little past mile 64 there is characteristic slate conglomerate, containing granite pebbles and some large boulders, and this continues most of the way to Dean Lake station, about three-quarters of a mile, where the granite crops out a little to the south. Several hours of careful search showed no actual contact of the conglomerate with the granite, though the impression was left that the conglomerate and slate are much younger than the Laurentian, and that the conglomerate has been formed of materials derived from the granite. In one or two places the conglomerate is cut by a basic eruptive and in one place by a reddish fine-grained rock like felsite, but no granite dikes were observed in the Huronian.

A road leading north from Dean Lake station crosses at 300 paces an outcrop of conglomerate 100 paces wide; at 700 paces there is red quartzite dipping 60° to the southwest; at 1,000, greenstone, and west of 1,860 paces, impure limestone, with slaty layers, having a strike of 115° and a dip of 30° southwest. At a mile and a half slate is found with a strike of 120° and nearly vertical dip, followed after 150 paces by nearly flat slate conglomerate, which continues, except for a patch of greenstone, almost to the Iron Bridge across Mississagi river, a breadth of nearly a quarter of a mile. Along the river there are stratified clays, but farther to the north hills rise showing a variety of rocks. A little northwest of the bridge a dome-shaped hill consists of conglomerate in the lower part, capped by red quartzite or arkose. The conglomerate at this and other points to the north contains many pebbles and boulders, some reaching diameters of three to six feet, the largest being of granite, though greenstone, banded jasper, black chert, slate and quartzite also occur. The red quartzite rests on the conglomerate, with a dip of 5° to the south, and for some miles to the north of this there are arkose, slate, white quartzite and conglomerates with very gentle dips toward the west or south, the highest recorded being 20°.

The considerable amount of conglomerate may be held to justify the mapping of most of the region as slate conglomerate; but it is evident that there are two series of rocks, separated by a basal conglomerate, along Mississagi river and to the south. The part with gentle dips is undoubtedly Huronian, but the steeply dipping quartzite and slate must be far older, and should not be included in the same series as the flat-lying conglomerate containing pebbles of the quartzite and slate. The rock found nearest to the granite is the conglomerate, suggesting that it rests basally on the Laurentian and other old rocks, including the Keewatin and the Sudburian.



Basal Huronian Conglomerate, Islands east of Thessalon

The Basal Huronian Conglomerate

Going westward from Dean Lake on the railway one encounters mainly granite and gneiss, with inclusions of greenstone and green schist, like the western Keewatin, rising out of old lake deposits and swamps. For fifteen miles one follows lengthwise the area mapped as Laurentian by Logan and Murray. About three miles east of Thessalon station boulder conglomerate is found in low hills rising from a swamp to the south close to the Laurentian gneiss, and made up chiefly of Laurentian materials. It has the same characters as the often described basal conglomerate on some small islands four miles east of Thessalon harbor, and is no doubt continuous with it. Beyond the basal conglomerate come the amygdaloidal rocks, placed by Logan as No. 2 of the Huronian, but now generally held to be of Keewatin age.

As it has been proved on the islands east of Thessalon that Logan's lowest Huronian, the "grey quartzite," rests upon the basal conglomerate just mentioned, it is entirely probable that the conglomerate found near the granite just north and east of Dean lake is of the same age and that much of the "lower slate conglomerate" put by Logan and Murray above the "grey quartzite," the "green chloritic slate" and the "white quartzite" is really basal. Probably part or all of the lowest quartzite, however, is much older, in fact pre-Laurentian and a part of the Sudbury series.

From the brief account of the rocks near Dean lake it will be seen that the geology of the Huronaian region is far less simple than the map represents it, and a detailed survey of the region under modern conditions is very desirable. That there is an actual basal conglomerate beneath the Huronian sediments at two points in the typical region has been proved by Irving, Van Hise and Leith, and others; and that such a conglomerate probably rests on the Laurentian and also on steeply tilted quartzite and slate near Dean lake is shown above. If the Thessalon lavas are removed from the Huronian and placed either in the Keewatin or Sudbury series, the Lower Huronian conglomerate of Logan and Murray is brought into line with the suggestions just made, and where it has been correctly mapped it is probably identical with the basal conglomerate referred to above. A glance at the map of the typical Huronian shows how frequently the "lower slate conglomerate" is in contact with the Laurentian or with greenstone or "green chloritic slate," probably of Keewatin age. So far as my observations go this is not due to faulting as suggested by Logan, but represents a great unconformity of the conglomerate upon older rocks. Where "gray quartzite" or "white quartzite" are found beneath this conglomerate they are really far older than the Huronian and are to be reckoned as of Sudburian age.

It might be suggested that since outcrops of these lower sediments were mapped as parts of the Huronian they should still be included in that series; but it is evident from the letterpress of the geology of Canada in 1863 and the sections shown in the atlas that Logan himself considered the Huronian much later than the Laurentian. That he was puzzled by some of these areas of older rock is shown by the statement that "what is supposed to be the lowest Huronian mass . . . . consists of a grey quartzite which abuts against one mass of gneiss and runs under another, and appears to be much broken by and entangled among the intrusive rock."[27] This grey quartzite is really Sudburian in age.

It may be mentioned that another outcrop of the basal conglomerate occurs about nine miles north of Sault Ste. Marie, in the township of Aweres, beyond the band of Huronian shown on the map. About seven miles north of the city, on the Great Northern road, coarse red granite shows at Granite station on the Algoma Northern Railway, near which it has been quarried. The same rock, followed by well-banded gneiss, extends for a mile or two beyond this, as seen along a lumber road near Trout and Birch lakes, and encloses a small band of iron formation, consisting of banded grey silica and magentite, on which a few test pits have been sunk. Two hundred yards north of the iron range, but separated from it by drift, a wide band of conglomerate begins with a matrix of coarse granitic materials enclosing granite pebbles and boulders, much like the basal conglomerate east of Thessalon. Though it has not been seen in contact with the Laurentian it is less than 250 yards from it and is composed almost entirely of fragments derived from the granite. Conglomerate and quartzite extend for a mile and a quarter to the north, beyond which the road was not followed. It can hardly be doubted that careful field work will disclose other localities where the basal conglomerate either rests on the old rocks or is composed so largely of their debris as to make its basal character certain.

To include two pre-Laurentian series, such as the Keewatin and Sudburian, in the Huronian merely because small areas of them failed to be separated in the early work done under unfavorable conditions is quite unjustifiable. The longest known gap in Canadian geology intervenes between the Sudbury series and the Huronian, a gap which included the elevation of great mountain chains and their complete destruction, leaving only a peneplain. To put together as one series pre-Laurentian and post-Laurentian rocks is to rob pre-Cambrian classification of all significance.

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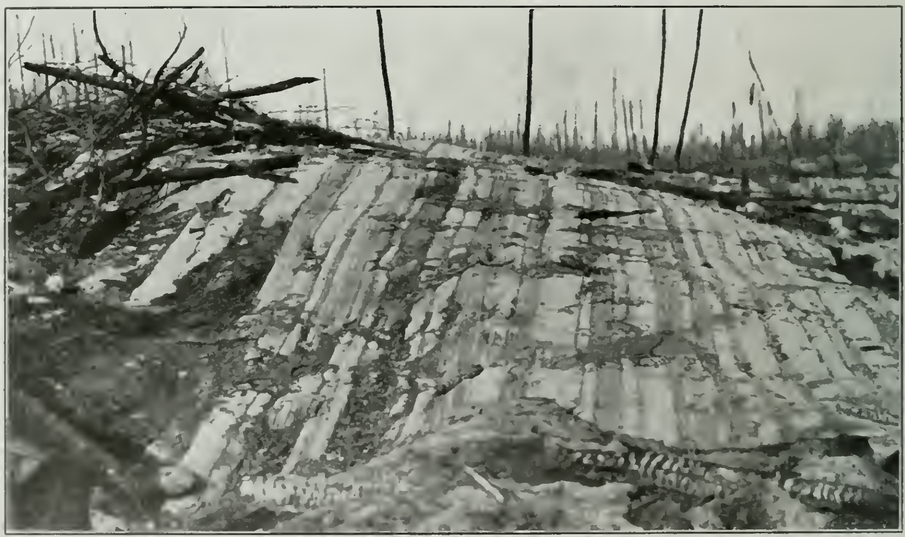
[27] Geol. Can., 1863, p. 55.

Other Areas Probably of Sudburian Age

The region just described includes much the largest known area of sedimentary rocks later than the Keewatin and Grenville but earlier than the Laurentian upheaval, but rocks apparently of the same age are found in many other parts of the Canadian pre-Cambrian. Those that have been most carefully worked out belong to the Temiskaming series, first recognized near Cobalt by Miller and Knight, but since extended by these geologists with Burrows and others to the Gowganda, Larder lake and Porcupine regions. Their extent is shown on the general map of the Sudbury-Cobalt-Porcupine region, published in 1913.[28] A good summary of the characters of these rocks and of their relations is given in the recent reprint of the Cobalt Report.[29] The description of these steeply tilted sediments, sometimes thousands of feet thick, corresponds exactly with what has been said of the Sudbury series, except that the granites upturning and penetrating them are called Lorrain instead of Laurentian. In the rocks themselves the main difference is in the larger proportion of conglomerates. The Temiskaming series is so well, though concisely, defined in this report that no further reference to the subject is needed here.



Quartzite and Greywacké, Timiskaming Series, Porcupine

Not far from the Larder lake area, but in the province of Quebec, Morley Wilson has defined the Pontiac series in a way suggesting that it is of the same age, though the absence of quartzite makes the correlation less certain, the sediments consisting of conglomerate and arkose, generally sheared and passing into mica schist.[30]

The Matagami series described by Bancroft farther to the north in Quebec is probably the equivalent of the Pontiac series, and may be placed in the same position.[31]. If this is correct the Sudburian rocks extend for 260 miles northeast of the Sudbury region, and it may be expected that future work will bring to light large or small outcrops at intermediate points between these rather widely scattered areas. That outcrops of schist conglomerate containing Keewatin pebbles and caught in the Laurentian uplift occur at numerous points where the rocks have been mapped as Keewatin or Huronian is certain, and sometimes isolated patches of the kind may be found enclosed in the Laurentian itself. North of Sudbury, near Clear lake, a mile or two beyond the northern nickel range, there is such a patch, and there are instances in the township of Hutton and northwest of it.

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[28] To accompany Part I, XXII Report, Ontario Bureau of Mines.

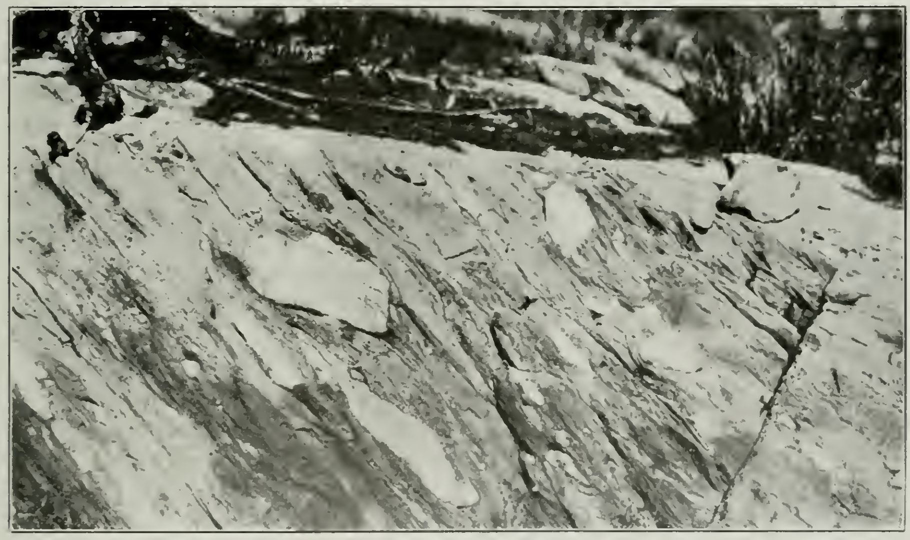
[29] Part II, XIX Report, Ontario Bureau of Mines, 4th ed., 1913, pp. 62-69.

[30] Sum. Rep. Geol. Sur. Can., 1911, pp. 274-6.

[31] Dept. Mines, Que., 1912, pp. 157-163.

Sudburian rocks occur also on a fairly large scale near Whiskey lake, twenty miles north of Spanish river and separated from the southern rocks of the series by a wide band of Laurentian.[32]

To the northwest of the Sudbury region there is, so far as known, a long interval of Laurentian granite and gneiss before rocks of Sudburian age are encountered. One hundred and fifty miles away, at Doré river in the Michipicoten district, schist conglomerate containing pebbles of Keewatin iron range rocks and caught with the Keewatin in synclines between batholiths of the Laurentian extend along the shore of Lake Superior for fourteen miles and then bend north and finally west with a length of more than thirty miles. The Doré conglomerate was called Huronian by Logan, but the evidence given in former pages, showing that the typical Huronian is later than the Laurentian, makes it necessary to place the Doré rocks in the next lower series, the Sudburian.[33]



Conglomerate, Timiskaming Series, Porcupine

Seventy miles farther northwest, at Heron bay on the north shore of lake Superior, there is a similar band of conglomerate older than the Laurentian;[34] and on the Slate islands, south of Jackfish bay, schist conglomerate containing jasper pebbles is interfolded with the band of iron formation which supplied them. It is older than the Laurentian uplift, but younger than the Keewatin and hence of Sudburian age.[35]

On the east shore of Lake Nipigon at Poplar lodge, sixty miles northwest of Jackfish, a band of pre-Laurentian conglomerate with jasper pebbles has been followed fifteen miles, parallel to the iron ranges of the region. It is associated with phyllite and arkose, but not quartzite, and has a width in places of a third of a mile.[36] E. S. Moore has found similar rocks near the Onaman iron range farther to the north.[36a]

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[32] Bur. Mines, Vol. XXI, Part I, pp. 146, etc.

[33] Geol. Can., 1863, pp. 53-4; also Bur. Mines, Vol. XI, pp. 162, etc.; and Vol. XIV, J. M. Bell, pp. 340-6.

[34] Bur. Mines, Vol. VIII, Part II, p. 167.

[35] Ibid., Vol. XI, p. 137.

[36] Ibid., XVII, pp. 142-3. [36a] Ibid., pp. 183-4.

It may be said in a general way that almost all of the areas mapped as Keewatin or Huronian in northern Ontario include to a greater or less extent such schist conglomerates younger than the Keewatin and older than the Laurentian.

West of Lake Superior, rocks probably equivalent to the Sudbury series extend in long bands near Seine river, and have been called by Lawson the Seine river series. They are, however, 200 miles from the nearest Sudburian rocks mentioned above, so that their equivalence is not so certain.[37] If these are admitted the similar conglomerates at Rat Root bay and near Lake Manitou to the north must be considered Sudburian also. After personal examination of the outcrops it may be stated that these schist conglomerates and associated sediments are like those referred to the Sudburian in eastern localities. They are later rocks than the Keewatin and have been uplifted and folded by granites and gneisses mapped as Laurentian.

That rocks with similar relations occur much farther to the north has been shown by Dowling near Red lake (lat. 51°, long. 93°-94°), where quartzite, slate and limestone occur with a conglomerate containing jasper pebbles, all being penetrated by granite, presumably Laurentian in age.[38]

All of the groups of rock referred to have important features in common, they are sediments, mostly coarse in nature, they are later than the Keewatin, and they have been upreared and more or less metamorphosed by great out-breaks of granite having the characters of the Laurentian. Usually they have been completely lifted from their foundations, though Lawson describes the Seine series as still in place on an ancient weathered surface near Mine Centre.[39]

If the whole of the areas just mentioned are of the same age, which is highly probable, there was at the end of the Sudbury time a great belt of conglomerates, greywackés, slates, arkoses and sandstones stretching for 700 miles from east to west and in places at least 260 miles wide. These were domed or tilted into mountain ranges by the Laurentian upheaval; and the greater part of them were destroyed during the slow removal of the Laurentian mountains. At present only remnants are preserved where deeply sunken into the Laurentian magma.

Extent and Character of the Huronian Basal Conglomerate

The separation of the Sudbury series from the Huronian as previously defined depends mainly on the tracing of the basal conglomerate which has been described as overlying the Laurentian and the upturned Sudburian sediments at several points. It will be useful to run over the localities and show how complete the evidence is.

Though the section given by Logan puts the "Lower Slate conglomerate" fourth in succession above the base, i.e., above the Laurentian, there is reason to believe that this is an error. The "green chlorite slate" put second in the series, has been shown to be older than the Huronian, probably Keewatin; the "gray quartzite," the first in Logan's list, undoubtedly rests upon the basal conglomerate on the islands east of Thessalon and so is later in age; while the "white quartzite" as seen by myself near Dean lake is almost certainly older than the conglomerate, so much older that it must be put in a more ancient series, the Sudbury series. With these explanations we may consider the lower conglomerate as the basal member of the Huronian. It has been found resting on the Laurentian and made up chiefly of Laurentian debris at the following points in the Original Huronian region: On islands four miles east of Thessalon, south of the railway three miles east of Thessalon station, and on a hill half a mile north of the road between Sault Ste. Marie and Garden river. It probably has the same relations seven or eight miles north of the Sault and also east of Dean Lake station where the two rocks occur near together, though actual contacts have not been found.

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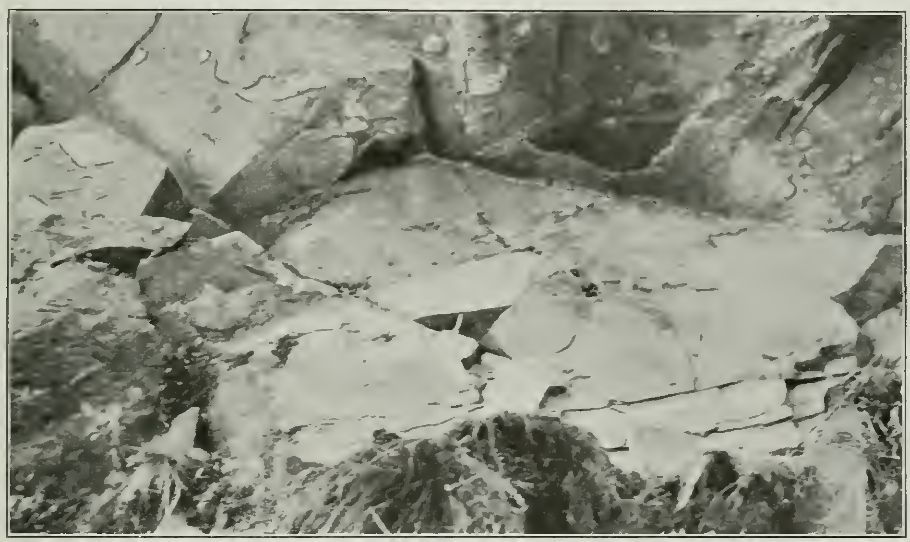
[37] G. S. C., Sum. Rep., 1911, pp. 241-2; also Guide Book No. 8, Geol. Congress, p. 58.
[38] G. S. C., Vol. VII, 1894, pp. 47 F.
[39] Geo. Congress, Guide Book No. 8, p. 58.

A little farther east near the Sault railway what is believed to be the same basal conglomerate has been found from point to point resting on the upturned rocks of the Sudbury series. The first occurrence, south of the railway at Algoma, does not show the relationships clearly, though the conglomerate includes pebbles of quartzite like the steeply tilted Sudburian quartzite close by. South of Walford on the north shore of Spanish river hills of conglomerate with quartzite pebbles rest on tilted quartzite for half a mile; and similar conglomerate with quartzitic matrix and sparsely scattered boulders and pebbles is found on hills just south of Espanola station. Three miles south of the town of Espanola near the Algoma Eastern railway a greywacké conglomerate rests with a well-marked unconformity on Sudburian quartzite. The contact is continuous for a third of a mile and what appears to be the same conglomerate occurs a mile west at several points for two miles to the southwest.

A few miles to the east on Lake Penage conglomerate areas occur at the west end and at various points on the north shore; as well as on the south shore of Round lake, the next to the east. The same type of conglomerate runs for more than a mile east of Ramsay lake and also forms an area of more than a square mile on its north side, showing in several places a striking discordance with the tilted quartzite beneath, which has a smooth surface. Nine miles east of the Ramsay lake area a band of conglomerate runs northeast for several miles, and similar conglomerates have been shown by Collins to continue to Gowganda and to Cobalt, where the famous silver bearing conglomerate is pretty certainly of the same age.



Smooth surface of Quartzite under Tillite, north of Ramsay Lake

The basal conglomerates in these localities have many features in common though the matrix varies, as would be expected, with the character of the rocks beneath, being arkose above granite or gneiss and greywacké or quartzite above other rocks. There are always several kinds of rocks enclosed, invariably granite boulders, even when several miles from any granite outcrop, and almost invariably greenstones or green schist and also banded silica and iron ore from the Keewatin, as well as quartzite, greywacké or slate from the Sudbury series. Usually the pebbles and boulders vary from angular to subangular and well rounded; and in most places a little search will show boulders with diameters of one or two feet, larger than flowing water would readily transport, while in several places boulders with diameters of from four to eleven feet may be seen.

On the other hand, there is great diversity in the proportion of boulders to the matrix, some of the conglomerates being made up mainly of large and small fragments crowded together, while others have the boulders very sparsely scattered. Well marked bedding is seldom found in the actual basal conglomerate but stratified materials are often found just above it or intercalated between two sheets of the conglomerate. The features mentioned are characteristic of tillite.

In a number of places the conglomerate rests on rock which was evidently weathered *in situ;* but in at least five places the underlying rock surface is clean swept and smooth or gently rounded. Examples of the latter are seen south of Espanola, on the north shore of Ramsay lake, and on the other side of the same conglomerate area half a mile north, at two or three places in the Gowganda region, and as pointed out by Dr. Miller, near Doherty station on the T. and N. O. railway.

Relation of the Sudbury Animikie to the Huronian

The rocks enclosed in the nickel basin near Sudbury are isolated by the upturned rim of the sheet of nickel eruptive from the surrounding rocks and some uncertainty exists as to their age. In the first map of the region by Dr. Bell they were marked Cambrian, but in the text of his report it is stated that they "may be Upper Huronian or possibly Lower Cambrian."[40] In later writings they have generally been considered Animikie or, in accordance with the classification of the International Committee, Upper Huronian, which is the equivalent of the Animikie of Lake Superior. As this area is hundreds of miles from the nearest undoubted Animikie the correlation is naturally somewhat uncertain, since it is largely lithological. Dr. Collins has recently suggested the name Whitewater series for them because of this uncertainty. It has been shown on former pages that the Ramsay Lake conglomerate is the equivalent of the basal conglomerate in the typical Huronian region, and the suggestion has been made that the Trout Lake conglomerate, resting on the nickel eruptive and at the base of the series of sediments in the nickel basin, may be of the same age. The two conglomerates have some features in common. They are both coarse textured and contain many boulders of granite; and there are phases of the two which look somewhat alike. They are only seven and a half miles apart and if formed at the same time they should be closely alike, since the conditions would not have varied much in so short a distance; but a careful comparison shows that they differ from one another in important ways.

Before proceeding to compare them it is well to note that the Trout lake conglomerate, having rested for a great length of time upon a sheet of molten rock 6,000 feet thick, is in most places profoundly metamorphosed so that there is an actual transition between the conglomerate and the micropegmatite beneath. In many places also it has been squeezed into schist conglomerate and on the whole it looks far more ancient than it really is. Parts of it were even mapped by Dr. Bell as Laurentian gneiss. In order to get a correct idea of it the greatly altered sections along the Canadian Pacific railway should be left out of account and only the least modified parts should be used for comparison with other conglomerates. The least changed outcrops are on certain high and rough hills north of Cameron creek near Sultana mine, at the southwest end of the nickel basin, where the eruptive sheet is relatively thin and has had less effect than elsewhere. Here one finds a dark gray fine grained matrix enclosing pebbles and boulders of granite, quartzite and greenstone. The granite boulders are often three feet in diameter, and one was found with diameters of 3½ feet by 5 feet so that the rock suggests tillite. In various places the Trout Lake conglomerate contains pebbles of chert as well as those mentioned.

The Ramsay Lake conglomerate (basal Huronian) has a matrix of greywacké, much more silicious than that of the Trout Lake conglomerate, and thus far no chert pebbles or boulders have been found in it, so that the two have marked points of difference.

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[40] G. S. C., Vol. V, p. 12 F.

The Whitewater series includes also thousands of feet of tuff and of black carbonaceous slate, with a gray sandstone on top, the whole amounting to more than 9,000 feet. If we compare this with the typical Huronian 70 miles to the west we find only one variety of rock common to both, the basal conglomerate. The typical Huronian includes no tuff, black slate nor gray sandstone, and the Whitewater series lacks white quartzite, except in trifling amounts, red arkose, jasper conglomerate and limestone. The upper conglomerate of the Huronian has no equivalent in the Whitewater series. It will be seen then that the two series differ in every respect except that each has a basal boulder conglomerate.

If we compare the Whitewater series with the typical Animikie on Thunder bay, 400 miles west, we find that both have a basal conglomerate, a thick sheet of black slate containing anthraxolite, and a gray sandstone, sometimes called quartzite, however, on Thunder bay.

The tuff of the Whitewater series is lacking in the west; and the iron-bearing lower portion of the western Animikie, chert or jasper and siderite, is almost lacking in the east. It is evident that the resemblance between the Whitewater series and the typical Animikie is much more striking than that between the Whitewater series and the Huronian, though the former is far away and the latter close by. Unless more convincing evidence can be brought forward than any known at present the sedimentary series resting on the nickel eruptive should be considered Animikie.

As the series has been described in reports on the Sudbury region it will not be necessary to give details as to the subdivisions here.

The Keweenawan

Although rocks considered Keweenawan occur in or near the Sudbury and Huronian areas they are not so largely developed as to give them much importance in the scheme of classification, and they will be referred to here merely to complete the subdivisions of the pre-Cambrian. Near Sudbury the only rock classed as Keweenawan is the nickel eruptive itself; and the proof of its exact age is not very certain. Its metamorphism of the Trout Lake conglomerate which rests upon it proves that it is later than the Whitewater series, probably of Animikie age, but how much later is doubtful. It might be Cambrian or Ordovician so far as positive evidence goes, but the Keweenawan was a period of great eruptive and also irruptive activity and we are not aware even of dikes of eruptive rocks in Ontario which can be dated positively as Paleozoic. It is natural therefore to place the huge laccolithic sill of the nickel eruptive, 1¼ miles thick and covering more than 400 square miles, in the great volcanic period of the late pre-Cambrian.

Sedimentary rocks of Keweenawan age occur with eruptives at Point Mamainse, a little north of the west end of the typical Huronian. They are the usual coarse sandstones and conglomerates and will not be described further.

Summary

From the account of the pre-Cambrian north of Lake Huron just completed it will be seen that in a region 175 or 200 miles long from east to west and 50 broad from north to south, including the typical Huronian and the Sudbury district, there are rocks, both sedimentary and eruptive, of every recognized series of the pre-Cambrian of Canada, with the exception of the Couchiching, which Lawson places below the Keewatin some hundreds of miles to the west. There is no other known region where all the pre-Cambrian elements come so close together and no other so favorably placed to solve the difficulties of classification. It has the great advantage also that the first reasonably accurate map of the northern pre-Cambrian was made in the typical Huronian region and that authentic Huronian and Laurentian rocks as named by the founder of our geology occur there in characteristic outcrops. The region gives a fixed starting point from which to expand our knowledge of the most ancient formations. The following divisions can be distinguished, beginning with the oldest. The Keewatin (iron ranges, schists and basic eruptives); the Grenville (schists, quartzite and a little crystalline limestone); Granite eruptive through the older rocks; the Sudbury series (arkose, greywacké, quartzite, conglomerate and some basic eruptives); Laurentian granite and gneiss eruptive through all the older rocks; Huronian (conglomerate, quartzite, arkose, and limestone); Animikie (Whitewater series, conglomerate, tuff, carbonaceous slate and sandstone); Keweenawan (lavas, conglomerate and sandstone near Mamainse, probably the nickel eruptive, at Sudbury); Sault Ste. Marie sandstone and shale, probably Cambrian; Ordovician shales and Silurian limestone and shale on islands to the south.

Unfortunately the relations of these different formations are often difficult to work out, since fossils are found only in the Ordovician and Silurian, and the column of the more ancient rocks is nowhere continuous. In most of the earlier work the Grenville, the older granite, and the Laurentian have been confounded; and the Sudbury series and the Animikie have been confused with the Huronian. It has been the purpose of this paper to disentangle these two groups and to present an orderly sequence of rocks as to age. From the historical point of view the following was the succession of events:

KEEWATIN—Volcanic eruptions, mostly of basic lavas, and the deposit in the sea of sediments rich in silica and iron. The floor on which the deposits were laid down is unknown.

GRENVILLE—Deposit of muddy and sandy sediments on a sea bottom which is no longer known to exist. The relations to the Keewatin are uncertain.

A time of great granite eruptions tilting and metamorphosing the older rocks, followed by a prolonged dry land period of erosion.

SUDBURIAN—Coarse sediments due to the weathering under cool climate or possibly desert conditions of a land surface consisting largely of granite, producing boulders, gravel, feldspathic and pure quartz sand as well as mud. The deposits have characters suggesting that they may have been formed largely on land, on a floor not yet discovered; but volcanic eruptions showing pillow structure toward the close seem to have been submarine.

The Laurentian batholiths of granite and gneiss lifted the Sudburian and other rocks into mountain ranges which were later destroyed by weathering and erosion under continental conditions, producing a peneplain.

HURONIAN—Begins with boulder conglomerate or tillite resting on the pre-Huronian peneplain, formed under glacial conditions; followed by the shallow water of lakes or the sea, in which deltas, sometimes of pure quartz sand, but often containing much undecomposed feldspar, were spread out thickly, probably all under a cool climate. Some limestone formed.

ANIMIKIE—Boulder conglomerate followed by explosive volcanic activity when glass fragments fell into water and were buried later under thousands of feet of mud charged with organic matter. The series ends with the laying down of coarse muddy sand.

KEWEENAWAN—Great volcanic eruptions and formation of laccolithic sheets with subordinate coarse sediments. Probably warm climate and desert conditions, since the sediments are mostly red.

THE CHEMICAL COMPOSITION OF NATURAL GAS FOUND IN ONTARIO

By G. R. Mickle, Mine Assessor

Object of Investigation into Composition of Natural Gas

It seemed desirable to undertake an investigation of this kind both from the importance of natural gas as one of the mineral products of Ontario, ranking as it does about sixth in value, and also from consideration of the fact that no systematic examination has been made of this most interesting product in the past. All natural gas has been considered to be the same provided it would burn. Yet even minute changes in the composition may be of great importance as can be seen by the alteration of even a fraction of one per cent. of certain constituents. This was forcibly brought to the attention of many consumers during the last few months when a change was made in the source of supply sent into certain towns, the gas from Kent being substituted for that obtained from Haldimand, Welland and Norfolk. A reference to the analyses given will show that the disturbance was caused by about one-half of one per cent. of hydrogen sulphide. As far as the heating power was concerned, which is the only thing which gives the gas any value, this meant only an inappreciable change. Even if hydrogen sulphide had no calorific power, the substitution of such a small amount would be negligible, but it has a substantial fuel value, so the effectual change in the gas for heating purposes was insignificant; yet, the actual practical effect both to the producer and consumer was very considerable.

If less than one per cent. can make a difference in the composition of the gas it seemed desirable that the other ninety-nine per cent. should be investigated and a definite knowledge of its composition acquired. A study of the composition and the variations in this composition in different fields and different parts of the same field might not unreasonably be expected to be an aid in the exploration for gas.

General Considerations in Sampling Natural Gas

In order to determine whether and to what extent there are variations in the gas in different parts of the same field, it is obvious that the only method which can lead to this result is to take a number of samples from the wells direct and not from pipe lines supplied from a number of different wells. An analysis of a mixture from different sources can never determine variations in the sources themselves. Illustrations of this statement will be seen when the analyses are considered. Of course if the object of an analysis is to determine what kind of fuel is being supplied to any particular place, the sample is properly taken from the pipe line. No doubt many of the analyses quoted are made with this object, but they should not be confused with those intended to show variations in composition in different parts of the same field.

The only rational way to ascertain the composition of a gas in any field is to sample a number of wells distributed in some systematic way over the area in question before any considerable amount of gas is drawn from the field. It is plain that once gas is piped from any area the original disposition of the gas is altered, as it begins to flow towards the wells supplying gas to the mains to replace that which is drawn off. It can be readily seen that this will complicate matters and put it beyond our power to ascertain the absolute truth, but by taking samples in the way outlined above before the field has been drawn upon and then again from the same wells when the pressure has dropped say 20 per cent., and again after a further substantial drop in pressure, some close approximation of the true composition must be arrived at. As far as the gas in some of the fields in Ontario is concerned, it is too late to make a systematic investigation of it, although it will be seen in discussing the results of the analyses that probably there has been no great change in the composition of the gas, but in others, notably the Kent field, the degree to which the gas is exhausted is so small that the results are almost of as much value as if they had been obtained in the first days of operation, and, if continued as indicated above, in the end a true idea will be had of the composition and variations of the gas in different parts of this most interesting and valuable area. For fields which will be discovered in the future there is no reason why our knowledge should not be complete.

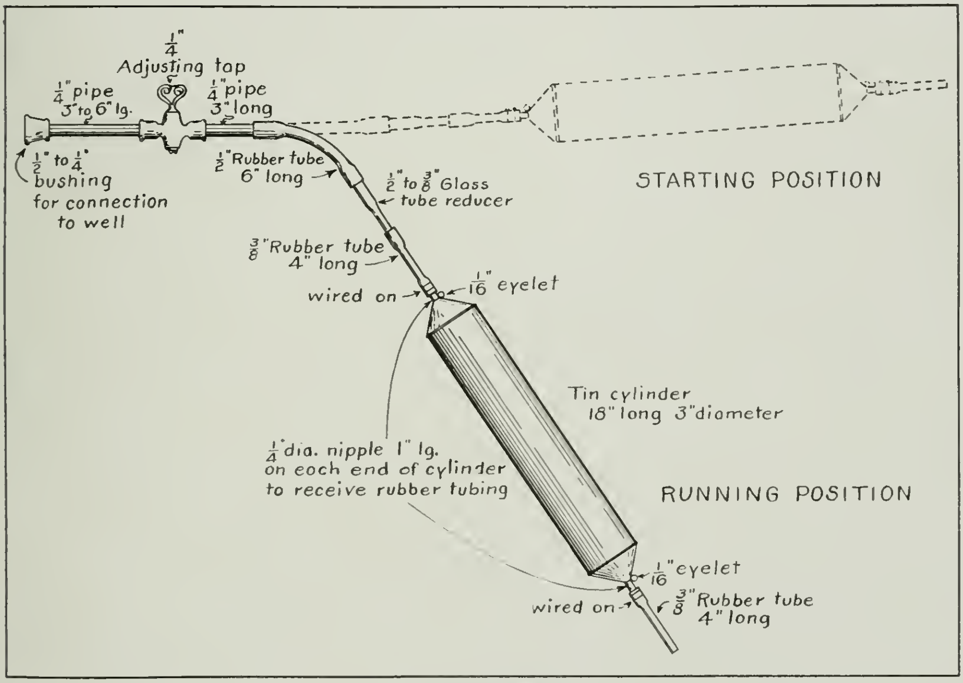
Method of Sampling

Having decided that the gas should be sampled at the wells the way in which this can best be done will be considered. The gas-holders must be convenient to handle and capable of containing an ample supply of gas for analysis. The writer first used those made of glass supplied by dealers in chemical apparatus and illustrated in their catalogues. These are simply glass tubes of various sizes, two inches more or less in diameter and four inches more or less in length terminating at each end in a small tube fitted with a ground glass stop cock. These did not appear to be convenient, the chief objection being their small capacity; they hold 250 to over 500 c.c. If it should be necessary to re-sample any well owing to the quantity taken at first proving insufficient, it would in some cases take several days to secure another sample. It seemed desirable, therefore, in order to provide against all accidents in the laboratory, to take a sample of gas containing not less than two litres. Glass vessels of any kind capable of holding this amount would be inconvenient to take to and from the wells, and accordingly it was decided to use metal holders, and tin cylinders as shown in accompanying sketch were made. These contain a little more than two litres. Before using, each cylinder was tested for leaks by plugging one end, connecting the other with a bicycle pump, holding under water and forcing air into it. Any leak is instantly indicated by bubbles. These tin cylinders were used in preference to steel ones, provided with taps at each end, on account of their lightness and consequent convenience in handling. Any cylinder provided with taps capable of holding gas perfectly must necessarily be fairly heavy in construction, whereas, these tin cylinders, which in the end proved very satisfactory and convenient both for the collection of the samples and afterwards in the laboratory could be made into a package of six or eight tubes and carried as conveniently as a small hand valise. The only point in which a tap is superior to the method used in closing the ends is that the tap is more conveniently closed. This cylinder is only to be closed once in the field, hence, there does not seem to be any reason for introducing taps with all the attendant anxiety about possible leaks at the tap.

A few preliminary samples were taken in the ordinary glass holders both by displacing water and displacing air. When water was used the gas was allowed to blow through about two minutes after the water was gone. If air displacement was used five minutes were given. These samples showed at the most 0.1 per cent. oxygen. Before the tin cylinders were tried, in order to have some measure of the time it would take to fill one of the tubes with gas at the rate it was allowed to blow through, provided the cylinders were empty, the cylinder was first filled with water and then gas or air blown in—the water was gone in less than one minute. Now the employment of the air displacement method is based on the assumption that there is some kind of uniform diffusion of air and gas in the holder used. If the gas is blown in at such a rate as to fill the cylinder in one minute, then provided the diffusion of the air and gas is perfect, at the end of one minute the mixture in the cylinder would be 50 per cent. air and 50 per cent. gas; at the end of two minutes it should be 25 per cent. air and so on. At the end of 10 minutes there should only be 0.1 per cent. air in the cylinder. In order to remove this and allow for irregularities, 15 minutes were decided on as a sufficient time, and the gas allowed to flow at a rate stronger than one could blow with the mouth.

Troubles with Air in Samples

A batch of 11 samples was taken in the way explained above. They were almost a complete failure. Only one contained no oxygen at all; another had 0.2 per cent., equivalent to 1 per cent. air; two more had a little less than 2 per cent. oxygen or less than 10 per cent. air and the rest contained over 10 and up to 30 per cent. air. The high oxygen samples were discarded as absolutely useless. The cylinders were tested again for leaks and found to be perfectly tight. Moreover, they were under slight pressure due mainly to the fact that the temperature outside on the days these first samples were taken was about 20°F. and of course the gas expanded on being brought into a laboratory at say 65°. Any leak would, therefore, have been outwards not inwards. The time was then increased to 25 minutes, and as the best results seemed to be obtained at the lower pressure wells where not such a strong stream was allowed to pass through, a gentler flow was used. Of the three samples taken this way one contained 1.4 per cent. oxygen or 7 per cent. air and was discarded; another had .1 per cent. and one a trace only. After this the water displacement method was used with entirely satisfactory results. Out of nearly 40 samples taken with water the worst showed only .1 per cent. oxygen, and in this case the rubber tubing shown in the sketch blew off towards the end of the operation and of course there was a chance for air to enter.



Gas sampling Cylinder

Mode of Sampling with Water

The operation with water was carried out as follows:—The tubes are most conveniently filled with water in town at a tap by slipping the ½ inch rubber tubing over the tap, holding the tube upwards and turning the water on partly till it flows out of the top of the cylinder. The two pieces of rubber tubing at the ends are then turned over and tied with string.

Details of Sampling at the Well

The method of sampling at the well can be seen by reference to the sketch. Most of the wells sampled had a ½-inch connection for a pressure gauge into which the ½-inch bushing was screwed. Then the valve on the well was opened till the maximum flow used in the operation was reached. This was about as strong as one could blow with the mouth. Then the adjusting tap was nearly closed so that only an extremely small flow of gas came through. The cylinder is then held slightly inclined upward as shown in sketch, and connection made with the glass reducer into the rubber tubing wired to the inlet end. The water of course immediately begins to flow, and, as it is reduced in quantity, the outlet end is gradually lowered, keeping thus always a water seal on the outlet. Towards the last the tube is nearly vertical. The water takes a little more than a minute to flow out. Then the adjusting tap is gradually turned on full and the gas allowed to flow through for five minutes. After this pinch the rubber tubing at the outlet end and almost immediately afterwards close the adjusting tap and pinch the rubber tubing at the inlet end. Detach this from the glass reducer and turn over both ends carefully and lash securely with string, taking care not to turn the rubber tubing over sharp on the end of the tin nipple, whereby it might be cut. At wells where the ½-inch connection was vertical an elbow was used, as it is most convenient to have the gas flowing out horizontally into the ¼-inch pipe. The writer believes that the water method is much the easiest and most satisfactory. With holders of any reasonable capacity the air displacement method must lead either to an unnecessary loss of time or occasionally spoilt samples. The method of sampling is given in detail as it is evident on seeing many of the analyses of gas published that the irregularity of diffusion of air and gas is not generally fully realized. A number of results showing oxygen are given for illustration. There is not the slightest reason for believing that there is a trace of oxygen in any of the Ontario gases. Further grounds for thinking that it never exists in natural gas will be given later on.

Difficulties in Sampling when Hydrogen Sulphide is Present in Gas

Some trouble was experienced in sampling the Kent gas with tin cylinders owing to the presence of hydrogen sulphide in the gas. It was anticipated that there would be some reaction between the metal cylinder and the gas, and the original plan was to take check samples for hydrogen sulphide only in glass holders from two of the wells. These could be small, say 250 c.c. It was thought that, as the cylinders were made of the same material and were of the same size, it would be shown that a certain definite amount of the sulphide would be eliminated and that this could be applied as a constant correction on all the other samples. It was found, however, that all the hydrogen sulphide was eliminated in the case of samples containing as No. 2, 0.3 per cent. It was therefore necessary to sample all the wells for hydrogen sulphide using glass holders. The sampler's trouble was caused by the fact that the hydrogen sulphide was too easily eliminated. Just at the very time this happened the producers and consumers of the Kent gas were having difficulties of exactly the opposite kind. This seemed an unnecessary aggravation to the sampler.

The presence of hydrogen sulphide in any gas is usually known beforehand. It is very easily identified by means of lead acetate. A *freshly made* solution of this salt was used in testing the Kent and all the gases except where this compound was known to be absent. If filter paper be moistened by the solution and exposed to the gas, a dark coloration is almost instantly produced by hydrogen sulphide. By noticing the difference in the rapidity and intensity of the coloration by gas from two wells the hydrogen sulphide of which has been determined quantitatively it was found that the percentage could be estimated approximately by the eye. With more practice and using a more dilute solution no doubt a fairly accurate determination of the hydrogen sulphide could be made.

For wells showing hydrogen sulphide by the lead acetate test, a small glass holder containing say 250 c.c. could be filled for the determination of this compound only, in addition to taking a sample in the tin cylinder for the other constituents. This would be easier than handling anything of glass capable of holding two litres.

History of Wells Sampled

General Statement

For convenience in referring to the accompanying map, all the wells which were sampled are numbered according to Counties, the boundaries of which are shown by heavy broken lines. The information regarding the wells which might have an influence on the composition was obtained from the owners of the wells. In some cases records had not been kept or wells had been sold and the history was not complete. Date of sampling and by whom taken is given for purpose of future reference. A brief statement is also made regarding each field. Commencing at the west end the various areas sampled are briefly described.

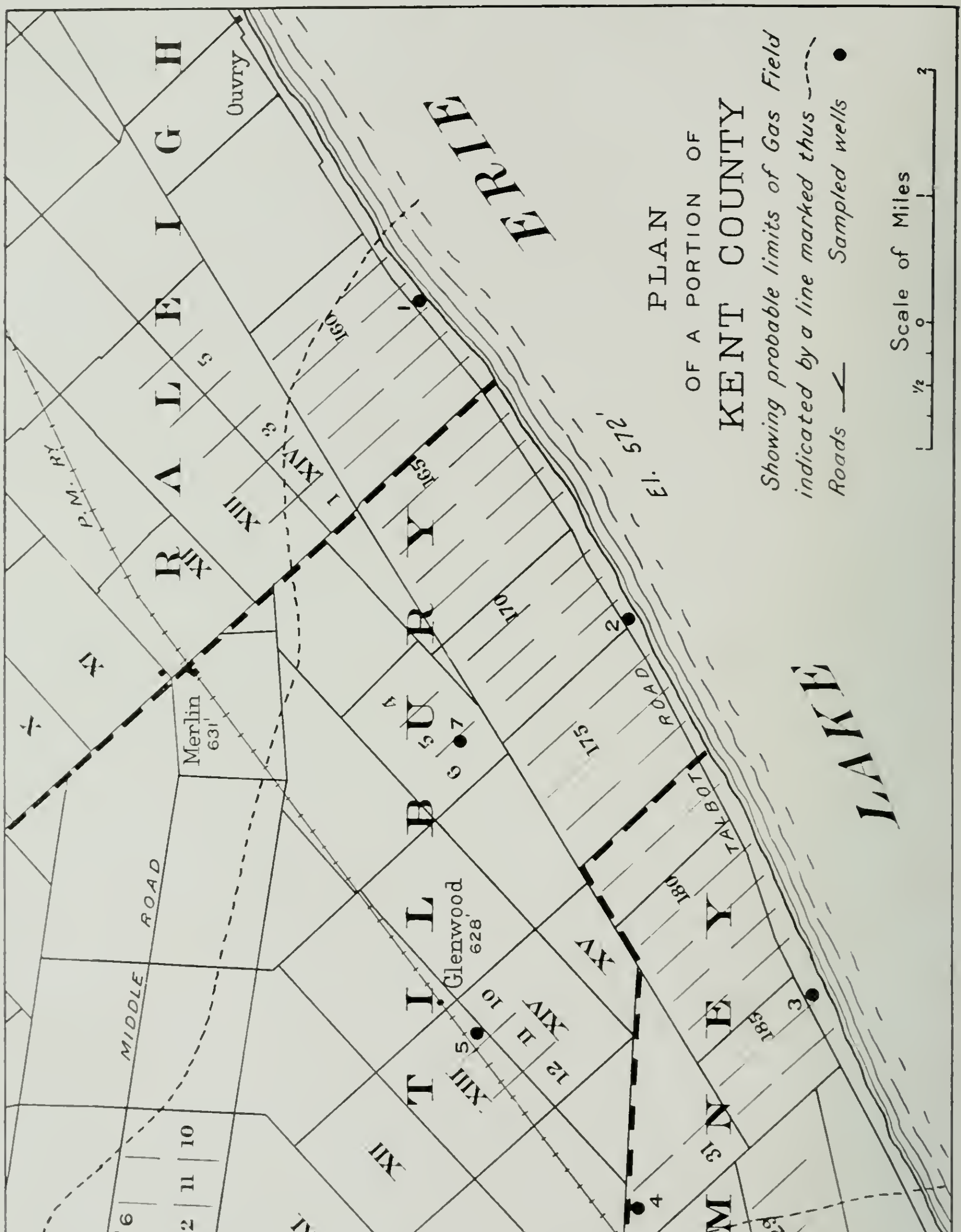
Essex Gas Field

This field was abandoned by the gas operators about two years ago. A few wells are still supplying gas to farm houses. The field was a small one, probably not over three square miles in area. A description with log of the first well drilled here is given in a paper by Eugene Coste entitled "Natural Gas in Ontario" (Jour. Can. Min. Inst. Vol. III). The following notes are taken from this paper. The well was drilled in January, 1889, on the extreme north end of the same lot as the one sampled. Gas was found at a depth of 1020-1031 feet in dolomite of the Guelph formation. The well measured over 10 million cubic ft. "open flow" and registered 460 lbs. pressure.

The particular well sampled was on the Fox farm, lot 7, Con. 1, Tp. of Gosfield South about 300 feet from Lake Erie. The original pressure of this well is said to have been about 500 lbs. and depth 1020 ft. The pressure is now about 50 lbs. This well is called Essex No. 1, in list of analyses and on the map. Sampled May 1st, 1914, by the writer.

Kent Gas Field

This small but valuable area first appeared as a gas producer in 1907. The production from this field up to the end of 1913 amounted to about 31,000 million cubic ft. The land area is about 31 square miles. It is often called the Tilbury field from one of the townships in which the gas is found, but a glance at the plan will show that the field takes in portions of the townships of Romney and Raleigh. All parts are not of equal value, the portion in Romney being particularly productive, and in general, the wells with the largest capacity are found in the southern part of the field adjoining Lake Erie. Undoubtedly the gas-bearing rock extends under the lake some distance. The gas is found in dolomite of the Onondaga formation. (Jour. Can. Min. Inst., Vol. X, p. 82.). The wells sampled were selected according to their location in such a way as to have a systematic distribution over the gas producing area. Owing to the difficulties explained under the description of the method of taking samples and to troubles caused by the presence of hydrogen sulphide, it will be noticed that the check samples taken for hydrogen sulphide in glass holders, and the general sample used in determining the other constituents were sometimes obtained on different dates. In all cases the capacity is the number of cubic feet in 24 hours as measured by the Pietot tube after the well was finished. All the samples in Kent were taken by the writer with the exceptions noted later on. This field is shown on plan to larger scale.



PLAN
OF A PORTION OF
KENT COUNTY
Showing probable limits of Gas Field indicated by a line marked thus
Sampled wells ●
Roads

Wells Sampled

KENT. No. 1—Well on the L. S. Baker farm, lot 161, Raleigh Tp. This well is 1424 ft. deep. Gas was found at intervals from 1310 ft.-1420 ft. Capacity 450,000. Original pressure 566 lbs. Pressure now 565. Drilled Jan., 1912. Check sample for H_2S taken in glass holder, March 3rd, 1914. General sample taken 11th April. Tested with lead acetate 23rd March and 11th April; on latter date gave faintly perceptible coloration in about 5 seconds, whereas No. 2, with 0.3 per cent. H_2S gave a strong color practically instantly.

KENT No. 2—Well on J. W. Askew farm, lot 173, Tilbury East Tp. Depth 1372 ft.; capacity 2,000,000 feet; drilled March, 1914; pressure 522 lbs. Sample for H_2S and general sample taken March 23rd.

KENT No. 3—Well on H. Baldwin farm, lot 185, Romney Tp. Depth 1387 ft.; gas found from 1140 ft.-1380 ft.; capacity 3,500,000; drilled July, 1911; original pressure 585 lbs.; pressure now when closed 5 minutes, 436 lbs. Sampled for H_2S April 11th; general sample, taken May 30th by Mr. L. Near, Field Supt. of Union Natural Gas Co.

KENT No. 4—Well on D. W. Lee farm, lot 31, Romney Tp. Depth 1380 ft; gas found 1260 ft.-1375 ft.; capacity 1,800,000; drilled Dec., 1913; original pressure 483 lbs.; present pressure when closed 5 minutes, 400 lbs. Sampled 23rd March; H_2S sample taken 11th April.

KENT No. 5—Well on Jas. Halliday farm, lot 10, Con. 13, Tilbury East Tp. Gas found 1260 ft.-1383 ft.; capacity 221,000; drilled early in 1913; original pressure 510 lbs.; now, 450 lbs. Sampled 23rd March for H_2S and general sample.

KENT No. 6—Well on R. & E. Graham farm, lot 12, Middle Rd. South. Depth 1365 ft.; gas 1303 ft.-1325 ft.; capacity 500,000 ft.; drilled April, 1907, for oil and bought from the oil operators. Original pressure not known; when purchased several years ago was 415 lbs.; now 418 (due no doubt to shutting off waste of gas in vicinity). Sampled 19th March (general) and 3rd March for H_2S.

KENT No. 7—Well on the Dawson farm, lot 6, Con. 15, Tilbury East. Capacity 2,000,000; drilled in 1909; original pressure 595; present 519; general sample taken 23rd March, for H_2S on 11th April.

Samples of the Surface Gas from the Drift taken in Kent

Two samples of this kind were taken in Kent. The results are discussed elsewhere under "surface" or drift gas. The exact location of these samples is shown on map.

Sample called "Howard Tp. Surface" was from a well drilled for water on lot 7, Con. 12, Howard Tp., on F. Fenningsdorf's farm. The information following is obtained from him. Well is 186 ft. deep and is in hard pan. No water at all was found in well. Rock said to be at 240 ft. depth in neighborhood. The well has been supplying gas for 21 years for all purposes in Mr. Fenningsdorf's house. Two other farm houses in the vicinity have been using gas from other wells for the same length of time and one other for two years. What this means in quantity will be discussed as indicated above. At the time the well was drilled the pressure was measured as 56 lbs., but has not been tested since. The owner states he cannot notice any drop in pressure. Sampled March 2nd by writer.

Sample marked "Raleigh Tp. Surface" was from water well 156 ft. deep on lot 1, Con. 12, Raleigh Tp. The owner of the well used the gas for a time in his house before the pipe lines of the regular producers were convenient. Have no estimate of the quantity produced by this well. Sampled 3rd April by Mr. L. Near, Field Superintendent of the Union Natural Gas Co.

Gas in Lambton County

This is a new field found by deep drilling in Oil Springs. Further details regarding this discovery will be found under "Natural Gas Industry in 1913." Two wells were sampled here, viz.:

LAMBTON No. 1—Fairbanks well, lot 18, Con. 2, Enniskillen Tp. Depth 1912 ft; gas found first at 1898 ft. Capacity said to be 15,000,000 ft. (Tube used only capable of measuring 11,000,000 feet); pressure 830 lbs. This well was drilled in only a few days before it was sampled by the writer on 21st March. Lead acetate test showed no trace of H_2S.

LAMBTON No. 2—Well drilled by the Oil Springs Co. This well was sunk in the summer of 1913. It is only about 700 feet distant from Lambton No. 1 (easterly in direction) consequently it could not be shown on the scale used on the map. Pressure probably same as No. 1, not measured. Sampled by the writer on 21st March. Lead acetate showed no trace of hydrogen sulphide.

LAMBTON No. 3—Well on east ½ of lot 26, Con. 4, Euphemia Tp. This well was still being drilled when sampled. Owners stated it was about 1700 feet deep and the gas was coming from about 1600. Capacity not known. Well not entirely closed when sample was taken by the writer from pipe leading from top of casing. Lead acetate showed no trace of H_2S.

Gas in Elgin County

This small gas producing area in Bayham Tp. was found in 1910. Only one sample taken here.

Elgin No. 1, from R. Balcom well No. 1, Vienna village. Depth 1330 ft.; original pressure 710 lbs.; present pressure 350 lbs.; drilled in Sept., 1910; gas in the Clinton. Sampled by Mr. Donald Sharpe, gas inspector for that district, April, 1914.

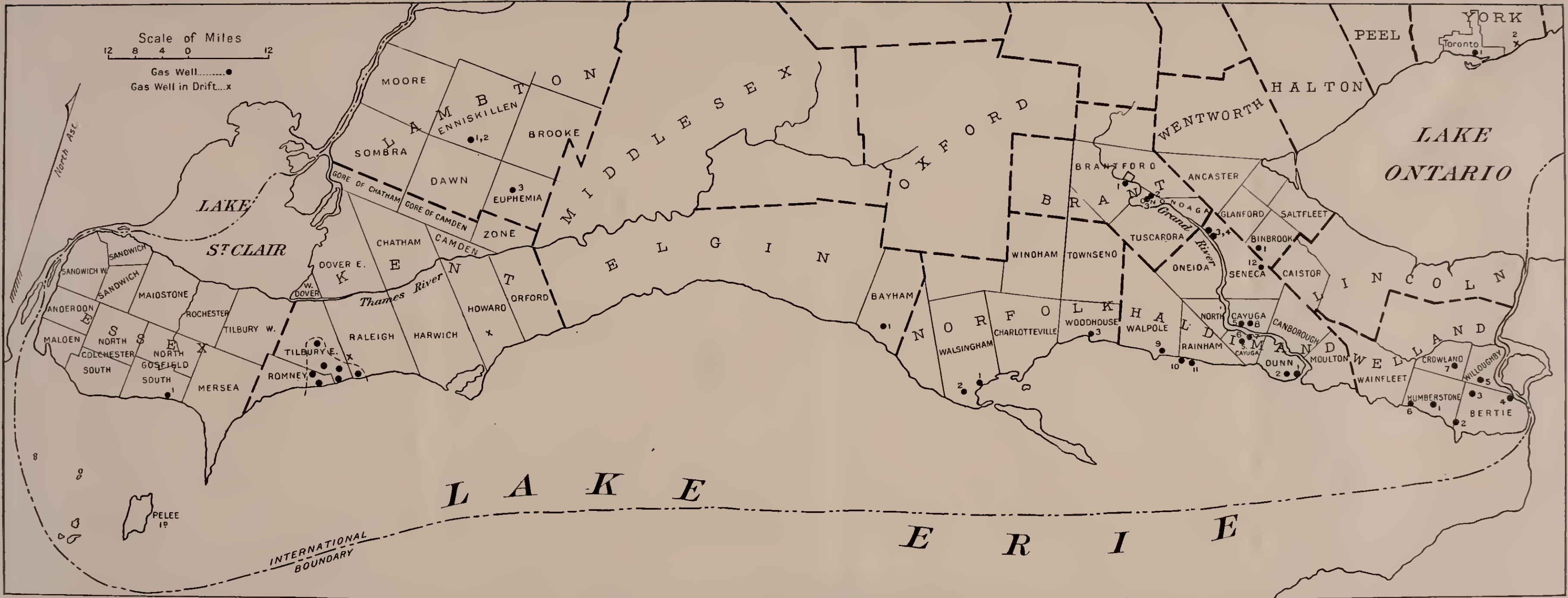
The Welland-Haldimand-Norfolk-Brant Gas Field

It is difficult to separate the areas in these counties. The first well was drilled in August, 1889, in Bertie Tp., Welland Co., about two miles north of Welland No. 2 shown on plan. This well measured 1,700,000 cubic ft. and was 836 ft. deep, gas being in White Medina sandstone. The pressure was 525 lbs. This information is taken from paper above quoted by Mr. Coste, which contains logs of a number of wells in Welland Co. Since that time the drilling has extended westward through Haldimand and Norfolk Counties and up into Brant and Wentworth. In general the gas-bearing rock does not extend back far from Lake Erie. Most of the gas is obtained from Clinton and the Red and White Medina. There are wells in all the townships fronting on the lake, beginning with Bertie in the East, through Welland, Haldimand and Norfolk. Probably the most productive townships have been Bertie, Humberstone and Rainham. It cannot be regarded as a continuous field. It will be noted that a number of the wells sampled are nearly exhausted, so that the possible influence of this on the composition can be studied.

Details of Wells Sampled in Welland-Haldimand-Norfolk-Brant-Wentworth Gas Producing Area

A brief statement is given of the history of the wells sampled in each of the counties. In many cases, owing to change of ownership or neglect of keeping records, the history is incomplete. All the samples in this territory were taken by Mr. Donald Sharpe, except where otherwise stated.

NORFOLK No. 1—J. R. Buck well, west part of Village of Port Rowan; depth 1420 ft.; pressure 450 lbs originally; present, 400 lbs. Gas in Red Medina. Sampled 15th April.



Map of Part of the Province of Ontario, showing Position of Wells Sampled.

April.

Norfolk No. 2—E. Foster well at Port Royal. Depth 1410 ft.; pressure now 400 lbs. Gas in Red Medina; sampled 15th April.

Norfolk No. 3—Well in Port Dover. Drilled Jan., 1912; depth 1043 ft. Mostly White Medina. Sampled 15th April.

Haldimand No. 1—Well on lot 25, Con. 3, Dunn Tp., in Port Maitland. Depth 880 ft.; original pressure 350 lbs.; capacity 1,000,000; pressure now 275 lbs. Gas in White Medina. Sampled 12th March by Donald Sharpe and the writer.

Haldimand No. 2—Well on H. P. Docker farm, lot 18, Con. 4, Dunn, south of Dover Road. Depth 930 ft; original pressure 465 lbs.; now 300 lbs.; capacity 470,000; drilled Nov., 1912. Gas in Red Medina. Sampled 8th April.

Haldimand No. 3—Well in Caledonia village. Depth 400 ft.; original pressure 245 lbs.; now 10 lbs. Gas in Clinton. Drilled in 1894. Sampled 3rd April.

Haldimand No. 4—The Wm. Carpenter well about one mile from No. 3. Gas at 390 ft.; pressure 245 lbs. originally; now, 140; drilled 1908. Sampled April 3rd.

Haldimand No. 5.—Joseph King's well, well north of the Grand River, North Cayuga Tp. Depth 725 ft; pressure now 225 lbs. Gas in White Medina. Sampled 17th April.

Haldimand No. 6—Well on Wm. Pridmore farm, lot 22, Con. 5, South Cayuga Tp. Pressure now 250 lbs.; depth 785 ft. Gas in Red Medina. Sampled 18th April.

Haldimand No. 7—Well on Jas. Topp farm, South Cayuga Tp. Pressure now 285 lbs.; depth 700 ft. Gas in Red Medina. Sampled 18th April.

Haldimand No. 8—Well on R. Windecker farm, lot 8, River Rd., North Cayuga Tp. Depth 735 ft. Gas in White Medina. Pressure now 250 lbs. Sampled 17th April.

Haldimand No. 9—Well on Joseph Steele farm, lot 18, Con. 1, Walpole Tp. Depth 960 ft.; original pressure 450 lbs.; now 87 lbs. Gas in Red Medina. Sampled 21st April.

Haldimand No. 10—Well in Lake Erie on water lot No. 1, Crown lease, opposite Rainham Tp. Drilled 1909; original pressure 500 lbs.; now 100 lbs. Gas in Clinton and Red Medina. Sampled 20th April.

Haldimand No. 11—Well in Lake Erie water lot No. 5, Crown lease, opposite Rainham Tp. Original pressure 500 lbs.; now about 100. Clinton gas. Sampled 20th April.

Haldimand No. 12—Well on S. McLeod farm, lot 13, Con. 4, Seneca Tp. Gas in Clinton at 397 ft. and White Medina at 497 ft. Drilled July, 1913. Sampled May 1st.

Wentworth No. 1—Well on David Hall farm, lot 23, Con. 9, Binbrook Tp. Depth 500 ft.; pressure 186 lbs.; drilled Dec., 1913, and shut in. Gas in Clinton and White Medina. Sampled May, 1914.

Brant No. 1—Well in yard of Cockshutt Plow Works, Brantford. Depth 550 ft. in Medina—some gas from Clinton too. Original pressure 310 lbs.: now 20 lbs. Capacity 775,000 at first, but dropped quickly, now very small, less than 10,000. Drilled in 1903. Sampled 4th April by Donald Sharpe and the writer.

Brant No. 2—Well on Wm. Macdonald farm, part lots 6, 7, 8, in 2nd Con., Onondaga Tp. Gas at 400 in Clinton and 515 in White Medina. Capacity 70,000, half from Clinton. Well not finished when sampled, (partly open) April 4th by Donald Sharpe and writer.

Brant No. 3.—Well on Wm. Brette farm, part of lots 6, 7, 8, in 3rd Con, Onondaga Tp. Gas in Clinton at 400; nothing in Medina. Depth 590 ft. Sampled April 4th by Donald Sharpe and writer. No. 3 is about half a mile from No. 2.

Welland No. 1—Well on south end lot 13, Con. 2, Humberstone Tp. Depth 830 ft. Original pressure 500 lbs.; now about 50 lbs. Capacity originally 500,000. Gas in White Medina. Drilled 1891. Sampled 8th April.

Welland No. 2—Well on lot 34, Con. 1, Bertie Tp. Depth 888 ft. Capacity 1,000,000. Original pressure 400 lbs.; now 100 lbs. Drilled April, 1910. Gas in White Medina. Sampled 11th March by Donald Sharpe and writer.

Welland No. 3—Well on east side of lot 12, in the 14th Con., Bertie Tp. Depth 578 ft.; original pressure about 360 lbs.; capacity 430,000 originally. Pressure now 100. Drilled July, 1897. Gas in Clinton. Sampled May 1st.

WELLAND No. 4—Well on lot 15, in the 5th Con., Bertie. Depth 565 ft.; original pressure 350 lbs.; now 120 lbs.; capacity 250,000; drilled Nov., 1907. Sampled 23rd March.

WELLAND No. 5—Well on lot 2, Con. 4, Willoughby. Gas at 2940 ft. in the Trenton limestone. Well was continued to the Archaean at 3030 ft. Capacity 250,000 originally and pressure 1000 lbs. Present pressure 100. Drilled in July, 1893. This is the deepest gas well in Ontario, and the only one in Trenton. Sampled 23rd March. Another well was sunk through the Trenton to the Archaean at 3257 ft. This well was about two miles southwesterly from Welland No. 3, but no gas was found in the Trenton. These notes are taken from "Natural Gas in Ontario," quoted above.

WELLAND No. 6—Well on J. J. Dickenson's lot in Port Colborne. Pressure now 185 lbs. Drilled in 1907. Sampled 10th April. Gas in White Medina.

WELLAND No. 7—Well on G. Jenkinson's farm, lot 7, Con. 4, Crowland Tp. Depth 550 ft.; original pressure 100 lbs.; now 6 lbs. Gas in Clinton and White Medina. Sampled May 2nd.

YORK No. 1—This sample was secured by the writer from a well drilled at the Dominion Bank building, King and Yonge Streets, Toronto, in Dec., 1913. The well was not drilled for gas and was almost immediately filled up with cement, the sample taken was leaking through the cement. No measurement was made of the capacity or pressure and the writer was not able to obtain any reliable estimate of the quantity. It does not appear to have been very important. Depth of well 1066 ft. Gas in the Trenton. Sampled Dec., 1913. This was not analysed in the same way as the other gases, but by the ordinary explosion one. The results are, therefore, given separately. Unfortunately the well was closed in altogether when the writer tried to secure a sample for the more accurate analysis later on.

York, Scarboro Tp., Surface

From well drilled for water at the St. Augustine Seminary, lot 25, Con. B, Scarboro Tp. The writer saw this for the first time, 20th Dec., 1913. Gas had then been blowing for seven days. Flow was measured and waste immediately stopped. Subsequently gas piped to boilers and used for three weeks under boilers. Eighteen burners were in use, about inch diameter. Flow of gas checked by water. Probably 4-5 million cubic feet were produced altogether by this well. Elevation of surface where well was sunk 525 ft. above sea. Well stopped at 330 ft. in shale (Lorrain). Gas mostly found at 290 ft. This particular vicinity is famous among geologists who have studied the Pleistocene especially and has been fully described by Dr. A. P. Coleman.* According to his description of a section in the vicinity the gas was in the Toronto formation which is composed of interglacial beds extending 151 ft. above Lake Ontario and 41 below. The lake level being 246 ft., the top of the well is 279 ft. above the lake, and therefore at 290 ft. the well is 11 ft. below the lake level. Details regarding well were kindly furnished by the Rev. Father Kidd, President of the Seminary. The well was sampled again on 29th Jan. and again on the 28th of March. The analyses by Prof. Ardagh made by the explosion method all showed olefines and carbon monoxide in quantities not varying much from those given in the case of York No. 1. No ethane was shown. The analysis that appears in the table is by the slow combustion method and was made on the last sample taken.

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* Excursions in vicinity of Toronto, Guide Book No. 6, Ontario Bureau of Mines.

THE ANALYSIS OF THE GASES

Methods of Analysis

By Professors W. H. Ellis, J. W. Bain and E. G. R. Ardagh,
University of Toronto

The most careful study of the methods of analysis for natural gases, which has yet been published, is contained in Bulletin 42, U. S. Bureau of Mines, under the title "The Sampling and Examination of Mine Gases and Natural Gas," by G. A. Burrell and F. M. Seibert. The results of this investigation have shown that the ordinary methods must be modified when applied to the examination of natural gas, and these conclusions have formed the basis of the present study.

Carbon dioxide was determined in the usual manner by absorption in potassium hydroxide solution.

Oxygen. Burrell and Seibert[1] have shown that alkaline pyrogallate is unsuitable for this determination and that phosphorus is also unreliable in the presence of large amounts of ethane and its higher homologues. In all the samples examined the ethane is comparatively low, and the higher members are present only in very small amounts so that no objection to the use of phosphorus could be raised on this ground. The usual form of phosphorus pipette was accordingly used, and nothing abnormal was observed during the investigation.

Carbon monoxide and olefine hydrocarbons: These have not been detected in the numerous samples analysed by Burrell and Seibert[2], and accordingly our vases were first examined qualitatively with the aid of a dilute solution of palladium chloride.[3] About 100 c.c. of the gas was transferred to a glass holder and shaken with 5 c.c. of palladium chloride solution (0.5 g. $PdCl_2$ per 100 c.c.); after standing for at least one hour, a sooty scum could be observed if these gases were present. To test the delicacy of this reaction, 0.3 c.c. ethylene was introduced into the gas holder with the palladium chloride solution, the colour of the latter changed immediately and in 5 minutes a sooty scum appeared. With 0.1 c.c. of ethylene the action took place more slowly; 0.5 c.c. of illuminating gas gave a reaction practically immediately.

Hydrogen: Palladium black[4] heated to 100°C. was employed for the detection of this constituent, and its presence could not be determined with certainty in any of the samples.

Paraffin hydrocarbons: These were determined by the slow combustion method in a sample from which the carbon dioxide and oxygen had been removed and in which the absence of carbon monoxide, the olefine hydrocarbons and hydrogen had been proved by the methods just described. One hundred c.c. of oxygen were first passed into the pipette and about 25 c.c. of the sample was slowly admitted while the spiral of platinum wire was maintained at bright red heat. In order to assure the completeness of the combustion, the mixture was passed into and out of the pipette twenty-five times, and the total contraction was then noted. The carbon dioxide was absorbed as usual and the results were calculated on the assumption that methane and ethane only were present.

Hydrogen sulphide was determined by Tutwiler's method.[5] Harding and Johnson[6] show that this method invariably yields much too high results with coal gas, due no doubt to the presence of substances other than hydrogen sulphide which are acted upon by free iodine. In the case of natural gases, however, consisting practically entirely of paraffin hydrocarbons, such errors would not be encountered.

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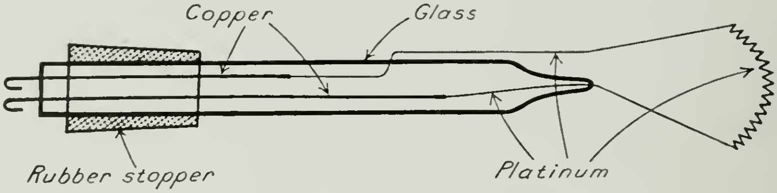
[1] Loc. cit., 87.
[2] Loc. cit., 76.
[3] Loc. cit., 80; Phillips, F. C., Amer. Chem. Journ., Vol. XVI, 1894, p. 267.
[4] Dennis, "Gas Analysis," Macmillan, 1913, p. 188.
[5] Jour. Amer. Chem. Soc., Vol. XXIII (1901), pp. 173-7.
[6] Harding and Johnson, 8th Internat. Cong. App. Chem., 1912, Vol. XXV, p. 673.

Apparatus Employed

The burettes and pipettes were of the Hempel form. The burettes were of 100 c.c. capacity divided to $\frac{1}{5}$ c.c. and water jacketted. For the determination of carbon dioxide and oxygen, water was used as the confining liquid, while mercury served for the combustions. The analyses were carried out in a room where the temperature was kept as close as possible to 20°C.



Apparatus for Gas Analysis

Several forms of the slow combustion pipette were tried which did not differ materially from the form recommended by Dennis.[1] It was found distinctly advantageous to introduce the two leads in the manner shown in the sketch. When the two leads were introduced separately through a double bored rubber stopper, it was difficult to make a gas-tight joint, and the effort to force the stopper home tightly resulted frequently in an objectionable distortion of the spiral. The latter was made of No. 32 platinum wire about 20 turns of about 1 mm. diameter.

Detailed Method of Analysis

The constituents for which tests were made and which were determined when present in the samples of natural gas examined are (1) Hydrogen sulphide, (2) Unsaturated hydrocarbons, (3) Carbon monoxide, (4) Hydrogen, (5) Carbon dioxide, (6) Oxygen, (7) Methane, (8) Ethane, (9) Propane.

For hydrogen sulphide a qualitative test was made with lead acetate paper at each gas well. When lead-paper was not blackened at the well, the quantitative estimation with iodine was, of course, omitted.

The following description sets forth in detail the procedure for gases on which all determinations were carried out:

Hydrogen sulphide was the first constituent determined; the sample collected in the glass holder being employed for this purpose. One hundred cubic centimetres of gas were drawn into Tutwiler's apparatus,[2] mercury being used as confining liquid, about 5 c.c. of freshly-prepared starch solution were then sucked in, and standard iodine solution (One litre contained 1.134 grams iodine. 1 c.c.=0.1 c.c. of hydrogen sulphide at 0° C. and 760 mm.) added a little at a time, shaking vigorously between each addition, until a standard blue colour resulted. Some time before the end-point was reached, a purplish-pink colour developed, reminding one strongly of the titration of hydrogen sulphide obtained from pig iron by the evolution method. It is a rather interesting fact that after all the hydrogen sulphide had been oxydized by the iodine, some of these gases still possessed a sickening stench far more disagreeable than hydrogen sulphide and not at all like it. This odour may possibly be due to traces of mercaptans.

The gas-sample in which the hydrogen sulphide had been estimated, was then examined qualitatively for unsaturated hydrocarbons and carbon monoxide by shaking it with palladious chloride ($PdCl_2$) solution. The test was made by sucking about 5 c.c. of 0.5% palladious chloride solution into a small glass sampling tube of about 150 c.c.

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[1] Dennis, loc. cit., p. 148.
[2] Jour. Amer. Chem. Soc., Vol. XXIII (1901), pp. 173-7.
[3] Hempel. "Gas Analysis," 1902 edition, pp. 237, 303.

capacity, evacuating the same by means of a water pump, introducing the sample of gas to be tested, shaking vigorously for perhaps a minute, and allowing to stand for some time. In not a single instance did any reducing action on the palladious chloride take place, even in cases where the gas samples were left for a whole day in contact with the reagent.

To determine the hydrogen, a sample of the gas, freed from hydrogen sulphide and saturated with water vapour, was mixed with oxygen and passed through a tube containing palladium-black heated in a boiling water-bath.[1] In every case the result was negative, or so nearly so as to be within the limits of error for the method.

To determine the carbon dioxide, 100 c.c. of the gas from which the hydrogen sulphide had been removed by shaking with a solution of lead acetate in distilled water slightly acid with acetic acid, were taken in a water-jacketted Hempel gas burette, water being used as confining liquid, and the carbon dioxide absorbed by potassium hydroxide (one of potassium hydroxide to two of water) in a Hempel gas pipette containing several rolls of iron wire gauze. The gas was passed back and forth into the pipette ten times to make perfectly certain of complete absorption; only, however, when the caustic potash was nearly exhausted did any further contraction take place after the gas had been passed twice into the pipette. The temperature of the water in the jacket was kept within 0.5° of 20°C. Before taking the reading, the burette was allowed to drain for two and one-half minutes.

After measuring the contraction due to absorption of the carbon dioxide, the gas was passed into the phosphorus pipette to remove oxygen. The use of phosphorus gave a very valuable qualitative (as well as quantitative) test for oxygen, since less than 0.1 c.c. of oxygen in 100 c.c. of gas will give a noticeable white fume. The pipette was filled completely with slender sticks of phosphorus. The few instances in which oxygen was found in small amounts probably indicate slight contamination of the samples with air.

After the removal of oxygen, the gas was passed into a water pipette from which samples could be conveniently taken for the estimation of the saturated hydrocarbons. The latter were determined by the method of slow combustion described by Dennis.[2] The confining liquid used both in the combustion pipette and in the gas-burette employed in connection therewith was mercury, water having too great a solvent action on carbon dioxide. The burette was water jacketted, and the temperature of the water was kept within at least half a degree of 20°C.

About 100 c.c. of oxygen were carefully measured and passed into the combustion pipette, then about 25 c.c. of residual gas were taken from the storage pipette, and its volume accurately read. The capillary connecting the burette and pipette was next cautiously freed from mercury and water, if any, the 110 volt current switched on, and the platinum spiral in the pipette brought to bright redness by cautiously manipulating a simple "nichrome" rheostat placed in series with a lamp resistance. The gas was now allowed to flow into the combustion pipette at the rate of about 10 c.c. per minute, the flow being controlled by a screw pinch-cock. The rate of flow permissible depends, however, very largely upon the form, size, position and temperature of the spiral, and possibly upon the shape of the pipette also. Combustion took place perfectly quietly. Great care must be taken to avoid shooting a single particle of mercury into the combustion pipette, since a drop striking the white hot wire will cut it like a knife. When all the sample had been run in, the gas was run backwards and forwards between the combustion pipette and the burette about fifteen times, not allowing the mercury to rise in the pipette to a point where the glass was at all hot. The current was now switched off, the pipette allowed to cool completely, the gas run into the burette, and the contraction in volume measured. The carbon dioxide was determined by absorption in caustic potash as described above, and the total volume of the paraffin hydrocarbons in the sample calculated from the formula $V = \frac{2\ T.C. - CO_2}{3}$ given by Dennis.[1] T.C. means "total contraction," and V stands for the volume of the paraffins.

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[1] Dennis, loc. cit., p. 196.

[2] Dennis, loc. cit., pp. 147-154.

Assuming methane and ethane to be the only hydrocarbons present, which was true for practical purposes in every case, we can calculate the percentage of each from the two combustion equations.

$$CH_4 + 2O_2 = CO_2 + 2H_2O \quad (1)$$

$$C_2H_6 + 3\tfrac{1}{2}O_2 = 2CO_2 + 3H_2O \quad (2)$$

If, now, we let $x =$ c.c. CH_4 and $y =$ c.c. C_2H_6, we can write

$$CO_2 = x + 2y \quad (3)$$

$$V = x + y \quad (4)$$

By subtracting (4) from (3) we get $CO_2 - V = y$ (5)

From equation (4) we have $V - y = x$ (6)

Let us take the figures obtained for duplicate samples of Kent gas number 4 to illustrate the solution of this problem.

	(1)	(2)
Volume of oxygen used in c.c.	100.0	100.0
Residual gas taken in c.c.	30.0	30.0
	130.0	130.0
Volume after combustion in c.c.	71.6	71.7
Total contraction in c.c.	58.4	58.3
Volume after absorption of CO_2 in KOH	40.7	40.7
Carbon dioxide in c.c.	30.9	31.0
$V = \frac{2\ T.C. - CO_2}{3}$	28.63	28.53
$y = CO_2 - V =$ c.c. C_2H_6	2.27	2.47
% C_2H_6	7.6	8.2
$X = V - y =$ c.c. CH_4	26.36	26.06
% CH_4	87.8	86.8

Since 0.5% hydrogen sulphide was present in this gas, the figures obtained for methane and ethane must be multiplied by $\frac{99.5}{100}$

The nitrogen is determined by difference. We should like to have checked some of the nitrogen figures by burning the gas over red hot copper oxide and measuring the residual nitrogen left after absorbing the carbon dioxide in caustic potash, but the time at our disposal was too short. It must also be kept in mind that these figures for nitrogen include any of the rare gases such as helium and argon which may be present.

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[1] Dennis, loc. cit., p. 131.

Analysis by Liquefaction[1]

The presence of propane or butane or both, in a gas containing methane and ethane, makes useless the results of the combustion method since only two values are obtained, the total contraction and the carbon dioxide, while there are three or four unknown quantities; the solution is therefore indeterminate. Until comparatively recently this difficulty has been insurmountable, but the attainment of very low temperatures by means of liquid air has opened up a new road for the attack of this problem.

Erdmann and Stoltzenberg[2] in 1910 described an apparatus adapted for this purpose and used it in the analysis of some simple gas mixtures.

Lebeau and Damiens[3] experimented with various mixtures of hydrogen and hydrocarbons using a different form of apparatus in which the mixtures were subjected to the low temperature of liquid air.

Burrell and Seibert, have also employed this method working along the same lines as Lebeau and Damiens. The sample was introduced into a cylinder immersed in liquid air, and as much gas as possible was removed by means of a mercury pump.

In the present investigation it was decided for convenience to employ the apparatus of Erdman and Stoltzenberg.

The hydrocarbons which are likely to occur in natural gas are:

	Boiling Point °C.
Methane	–160
Ethane	– 93
Propane	– 45
Butane	1

All these are therefore condensed to liquids at the temperature of liquid air, about –190° C., and the fractional distillation of the possible mixtures become a question of vapour pressures. At this temperature methane has a vapour pressure of about 8 cm., while the pressure of ethane is practically zero;[3] the higher hydrocarbons showing a behaviour similar to ethane. On subjecting a mixture of the above four paraffins to the temperature of liquid air, we should be able to remove the methane by pumping, leaving the three higher members as a liquid residue. Lebeau and Damiens[5] publish results showing a sharp separation of hydrogen and methane from ethane and propane, but we have been unable to secure equally satisfactory results.

In the present investigation, 100 c.c. of the gas were dried over phosphorus pentoxide and passed into a glass coil immersed in liquid air where liquefaction took place rapidly. After a few minutes the non-condensable gas was pumped off as completely as possible, which proved in some instances, to be a laborious operation. When no more gas could be obtained, the liquid air was removed, the condensate was allowed to gasify and was then measured. The non-condensable portion was again liquefied, and a second small condensate was thus obtained.

The entire fraction condensed was then analysed by the slow combustion method, and in some instances, the non-condensable portion also.

Circumstances would not permit the application of this method to all the samples taken, so that those which were high in ethane, as determined by a combustion on the whole sample, were selected. It is obvious that the presence of propane or butane or both in any gas, would lead, in the ordinary combustion method, to the conclusion that the amount of ethane present was higher than the real value, and hence those samples which were highest in ethane were examined first.

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[1] As this article was passing through the press, a careful study of the method of analysis by fractional distillation at low temperature has been published by G. A. Burrell and F. M. Seibert in the Journal of the American Chemical Society, Vol. XXXVI, p. 1537.

[2] Ber. deutsch. chem. Gesell, Vol. XLIII, 1910, p. 1702, 1708.

[3] Compt. rend., Vol. CLVI, 1913, p. 325; Gas World, Vol. LIX, 1913, p. 325.

[4] Loc. cit., p. 91.

[5] Lebeau and Damiens, loc. cit.

	Ethane by combustion on whole sample.	Ethane, propane, etc., by liquefaction.
Kent No. 2	10.8%	10.6%
Lambton No. 1	17.6%	11.6%
Lambton No. 2	18.4%	9.1%
Brant No. 1	9.5%	7.8%
Brant No. 2	19.0%	14.7%
Haldimand No. 2	11.4%	10.8%
Haldimand No. 7	16.3%	10.8%
Welland No. 1	17.3%	15.6%
Haldimand No. 1	21.3%	17.6%

It is unnecessary to give the details of the analysis of each of these condensates, but it will suffice to quote one for illustration.

In the case of Brant No. 2, the condensate yielded the following results:

	Sample No. 1.	Sample No. 2.
Volume of gas taken	14.4	15.0
Volume of oxygen added	98.8	99.9
Total volume	113.2	114.9
Volume after combustion	78.7	78.3
Contraction	34.5	36.6
Volume after potassium hydroxide absorption	51.7	50.1
Volume of carbon dioxide	27.0	28.2
Ethane	12.60	12.75
Methane	0.98	1.80

In all the consensates analysed only methane and ethane could be found, with the exception of Brant No. 1, Lambton 1 and 2, and Haldimand 1. Butane appears to be entirely absent in these gases.

Reverting to Brant No. 2, the above data furnish two concordant values, 12.60 and 12.75 per cent. of ethane in the gas, but these figures are much lower than 19.0, the percentage determined by combustion on the entire sample without liquefaction. A comparison of the values set down in the table shows that this is also the case in Lambton No. 1 and Haldimand No. 7, and we have endeavored to find some reason for these discrepancies. The condensations were usually carried out in duplicate and when some experience had been obtained, the volumes of condensate from two samples of the same gas did not vary by more than 1 c.c. on a 100 c.c. portion. A series of determinations were carried out on Welland No. 1 which was one of the first gases examined by this method, with the object of studying this difficulty; but no higher value for the condensate than that which is given above could be obtained.

The only explanation which we can offer to account for these variations is the well known fact that the vapour pressure of a liquid is altered by the addition of a second liquid; we have as yet no reliable method of calculating the amount of the change. The magnitude may be guessed from an observation that at −78°C the vapour pressure of liquid isobutane is raised from 12.7 mm. to 19.9 mm. by the presence of 0.9% of propane.[1] While, therefore, pure ethane may at the temperature of liquid air have a vapour pressure of practically zero, the presence of a large quantity of liquid methane which is slowly being removed at each stroke of the pump, will almost certainly result in the evaporation of some of the liquid ethane also. It may at once be said that this error in parallel experiments might be expected to show a uniformity, and we have tried with the greatest care to realize this prediction but without success.

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[1] Lebeau and Damiens, loc. cit.

In several cases the non-condensable gases were also analysed and proved to be mixtures of much methane and some nitrogen with small amounts of ethane. The quantity of the latter when added to that obtained from the condensate was still too low as compared with the value for ethane obtained by direct combustion.

Lack of time has prevented us from making a more thorough study of this problem.

The reason for the variations referred to above still remains undiscovered and the results actually obtained are given as a basis for the conclusions which have been drawn.

The data obtained by the liquefaction method, showing the absence of butane and higher homologues and the presence of propane in very small amount in only four samples, are taken by us to indicate the substantial accuracy of the combustion analyses. Any error which might be due to the presence of the higher paraffins may be regarded as entirely eliminated.

Note: It was the intention to carry out helium determinations on the most likely gases, i.e., the high nitrogen ones. It will be observed there were very few of these. Of two selected as promising one gave no helium and the other a distinguishable quantity. The rest of the highest nitrogen gases will be examined for helium later on.

TABLE I.

ANALYSES ONTARIO NATURAL GASES

Profs. W. H. Ellis, J. W. Bain, E. G. R. Ardagh, Chemists.

County and Well.	H_2S	C_2H_4	CO	H	CO_2	O	CH_4	C_2H_6	C_3H_8	N	Condensate.	lbs. on well.
Essex No. 1......	0.3	none	none	none	none	none	87.6	7.3	none	4.8	.....	50
Kent No. 1.......	trace	''	''	?	0.1	''	76.1	18.0	none	5.8	.....	565
Kent No. 2.......	0.3	''	''	none	none	''	84.4	10.8	''	4.5	10.6	522
Kent No. 3.......	0.6	''	''	''	0.1	''	86.0	8.5	''	4.8	.....	436
Kent No. 4.......	0.5	''	''	''	0.05	''	86.8	7.9	''	4.8	.....	400
Kent No. 5.......	0.4	''	''	''	0.3	''	83.4	10.6	''	5.3	.....	450
Kent No. 6.......	0.8	''	''	''	none	trace	78.2	15.7	''	6.1	.....	418
Kent No. 7.......	0.8	''	''	''	?	none	84.1	8.5	''	5.8	.....	519
Kent "Surface" Tp. Howard ...	none	''	''	''	none	''	83.0	none	''	17.0	.....	50?
aKent "Surface" Tp. Raleigh....	''	''	''	''	0.1	0.3	92.9	''	''	6.7	.....	?
Lambton No. 1 ...	''	''	''	''	none	none	68.3	12.5	3.4	15.8	11.6	830
Lambton No. 2 ...	''	''	''	''	''	''	69.0	15.7	1.8	13.5	9.1	830?
Lambton No. 3 ...	''	''	''	''	''	''	80.2	11.7	none?	8.1	.....	?
Elgin No. 1.......	''	''	''	''	''	''	84.1	10.8	''	5.1	.....	350
Norfolk No. 1	''	''	''	''	''	''	84.4	6.8	''	8.8	.....	400
Norfolk No. 2	''	''	''	''	''	''	83.8	7.7	''	8.5	.....	545
Norfolk No. 3	''	''	''	''	''	''	75.8	14.2	''	10.0	.....	?
Haldimand No. 1 .	''	''	''	''	''	''	67.8	16.0	3.5	12.7	17.6	275
Haldimand No. 2 .	''	''	''	''	''	''	79.7	11.4	none	8.9	10.8	300
Haldimand No. 3 .	''	''	''	?	''	''	76.7	14.6	''	8.7	.....	10
Haldimand No. 4 .	''	''	''	''	''	''	81.4	11.7	''	6.9	.....	140
Haldimand No. 5 .	''	''	''	''	''	''	79.4	14.3	''	6.3	.....	225
Haldimand No. 6 .	''	''	''	''	''	''	81.8	11.8	''	6.4	.....	250
Haldimand No. 7 .	''	''	''	''	''	''	76.6	16.3	''	7.1	10 8	285
Haldimand No. 8 .	''	''	''	''	''	''	76.3	15.4	''	8.3	.....	250
Haldimand No. 9 .	''	''	''	''	''	''	84.9	8.3	''	6.8	.....	87
Haldimand No. 10	''	''	''	''	''	''	77.6	15.4	''	7.0	.....	100
Haldimand No. 11	''	''	''	''	''	''	77.8	14.7	''	7.5	.....	100
Haldimand No. 12	''	''	''	''	''	''	80.0	11.4	''	8.6	.....	?
Wentworth No. 1 .	''	''	''	''	''	''	80.2	13.1	''	6.7	.....	186
bBrant No 1.......	''	''	''	''	''	0.1	76.9	8.0	1.2	13.8	7.8	20
Brant No. 2......	''	''	''	''	''	none	68.6	19.0	none	12.4	14.7	?
Brant No. 3......	''	''	''	?	''	0.05	74.6	15.4	''	10.0	.....	?
Welland No. 1....	''	''	''	''	''	none	74.8	17.3	''	7.9	15.6	50
cWelland No. 2....	''	''	''	''	''	0.2	80.0	12.9	''	7.1	.....	100
Welland No. 3....	''	''	''	''	''	none	82.1	13.5	''	4.4	.....	100
Welland No. 4....	''	''	''	''	0.05	0.05	83.6	12.0	''	4.3	.....	120
Welland No. 5....	''	''	''	''	0.15	0.05	93.7	3.3	''	2.8	.....	50
Welland No. 6....	''	''	''	''	none	none	75.6	15.5	''	8.9	.....	185
Welland No. 7....	''	''	''	''	''	''	85.9	8.7	''	5.4	.....	6
York No. 1.......	Result given separately below											
York Scarboro Tp. "Surface".....	none	none	none	none	1.65	''	85.15	0.0	''	13.2	.....	5

(a) As this gas was probably in contact with water and might have taken oxygen from that, we cannot assume the O was due to sampling; no correction is, therefore, made. The sample was taken by displacing water.

(b) This is the highest O in any sample taken with water. The rubber tubing was blown off during operation; no correction made.

(c) Corrected to air free sample. Taken "dry."

Analysis of York No. 1 by Prof. E. G. R. Ardagh.

Carbon dioxide	0.1
Carbon monoxide	1.2
Ethane	3.1
Hydrogen	none
Hydrogen sulphide	none
Methane	86.0
Olefines	1.3
Oxygen	none
Nitrogen	8.3
	100.0

Note.—The carbon monoxide and olefines appear in the analysis at the expense of the methane and ethane, but the relative proportions in which this took place are not known.

COMPOSITION OF NATURAL GAS

By G. R. Mickle

General Considerations

For convenience we may consider that there are three broad classes of natural gas, viz: (1) The "dry" commercial gases, that is, those that are found in such quantities that they are capable of utilization and are not intimately associated with oil; (2) The "wet" gases found in oil wells; (3) Those that are of no value, due either to lack of sufficient combustible constituents or their occurrence in insignificant quantities. It is the "dry" commercial gas with which we are concerned in Ontario, there being no evidence at present of the existence of "wet" gases in any important quantity.

Before proceeding further it may be as well to explain briefly the nature of the most important constituents, viz: the various hydrocarbons belonging to what are called the paraffin series or the saturated hydrocarbons which have the general formula C_nH_{2n+2}; e.g. where n = 1, formula is $CH_{2+2} = CH_4$ and so on.
The only ones found in the dry Ontario gases are:

Methane (CH_4) with heating power of 1067 B.T.U.
Ethane (C_2H_6) with heating power of 1865 B.T.U.
Propane (C_3H_8) with heating power of 2665 B.T.U.
B.T.U. standing for British Thermal Units per cubic foot of gas.

These data are taken from Thomsen's Thermo Chemistry, translated by Burke.

The only other constituent in natural gas having any heating value is hydrogen sulphide with 689 B.T.U.

The hydrocarbon series continues as follows:

Butane	(C_4H_{10})
Pentane	(C_5H_{12})
Hexane	(C_6H_{14})
Heptane	(C_7H_{16})

Taking all the reliable information available at present regarding the composition of the "dry" commercial gases, and it must be remembered that it is necessarily incomplete as it is not conceivable that all the variations and peculiarities in gas which may exist are known at the present time, we find that methane is the chief constituent, in some rare cases, perhaps, it is the only one, but usually with it are other hydrocarbon compounds, e.g. ethane or propane, and also, nitrogen, carbon dioxide and sometimes hydrogen sulphide. Many analyses published will show oxygen, carbon monoxide, olefines or illuminants, but the most reliable evidence points to the probability that these constituents never exist in natural gas. This matter is dealt with in the description of methods of analysis and need not be further alluded to here. None of these were found in any of the gases examined from Ontario. At the present as far as the writer can ascertain the maximum amount of the various constituents other than methane which are known to exist in "dry" commercial gases are as follows:

Ethane	27	per cent.	(a)
Propane	6	"	(b)
Nitrogen	46	"	(c)
Hydrogen-sulphide	0.8	"	(d)
Carbon dioxide....................	6	"	(e)
Helium	1.5	"	(f)

(a) Bull. 42, p. 87, U. S. Bureau of Mines. G. A. Burrell, Chemist.
(b) Bull. 42, p. 96, U. S. Bureau of Mines.
(c) Analysis No. 41, by Cady and McFarland, cited below among samples of gas.
(d) Analysis in present paper.
(e) Cady and McFarland, analysis No. 46, paper cited above.
(f) Cady and McFarland, analysis No. 41, given below.

These limits as stated before are certain to be extended by the analyses of gas discovered in the future. Extensions of these limits it will be seen can only increase the number of gases which may exist and therefore make the reasoning employed later on more forcible.

The Mathematical Theory of Combinations Applied to Natural Gases

It is clear that "dry" commercial gas is not a chemical compound, but is a mixture of the above mentioned different gases, the relative proportions of which are not regulated by any chemical laws, but any one of the constituents mentioned, ethane, nitrogen, &c., may vary from zero to the maximum given above for each. The resultant natural gas is a combination of certain different gases and the number of combinations or the number of different natural gases which might exist is, therefore, capable of calculation by the ordinary mathematical laws, just as the combinations of any other kind of things. In order to estimate the possible number of different commercial gases which might exist in nature it is first necessary to determine the maximum variation which might occur in one and the same gas. The question of the probable identity or difference of any two given gases must be decided by the analyses and as these are subject to error the magnitude of the errors must be taken into consideration. The accuracy of the analyses, assuming of course, that all the work is performed skilfully and according to the best methods, varies greatly with the different constituents. For carbon dioxide probably within .1—.2 per cent., while with ethane or propane the error might easily be 1 per cent. The term "error" being used here in the technical sense in which it is employed by the authorities on the Method of Least Squares, meaning inaccuracies of measurement as opposed to "mistakes" which can be eliminated by proper checks. As nitrogen is nearly always determined by difference, the error in the nitrogen must be equal in magnitude and opposite in sign to the algebraic sum of all the errors in the other constituents. The errors in the carbon dioxide or hydrogen sulphide being insignificant compared with those in the determinations of the hydro-carbons, they may be disregarded, and we can assume that the magnitude of the nitrogen error is the same as for the hydro-carbons. In comparing any two analyses of different samples of gas it is of course possible that the errors might be in opposite directions and that gases which contained exactly the same percentage of ethane, for instance, might show an apparent difference of 2 per cent. if one has the maximum plus error and the other the maximum minus error of 1 per cent. The difference must therefore be twice the error plus some constant. The question is how to determine that constant. Two ways appear to be available. In the first place, we not unreasonably might expect to have some light on this question by studying the variations which are found to occur in artificial gas.

Variations in Artificial Gas

The art of making artificial gas is about one hundred years old and those engaged in it have acquired an experience which ought to be of value with regard to variations. The usual practice is to deliver a gas to the consumer which is a mixture of coal gas and carburetted water gas. Each of these two in turn being mixtures of a number of gases. It is the coal gas which we will consider. This is made up mainly of methane and hydrogen, these two together accounting for about 80 per cent. or more of the total, the balance consisting of carbon dioxide, olefines, oxygen and nitrogen. Mr. Arthur Hewitt, General Manager of the Consumers Gas Co., Toronto, kindly furnished the writer with information regarding the variations in coal gas. The average daily amount of coal gas throughout the year made in these works is about 7 million cubic feet. The works are furnished with the very best equipment and every effort is made to deliver a uniform article. The coal gas, of which the analyses are given (Mr. Wilfred Philpotts, Chemist) is made in 300 retorts, which are fed regularly with carefully weighed amounts of the same material, the resultant gas from each retort is thoroughly mixed with the product from the other retorts before the sample is taken. Disregarding the other constituents except methane and hydrogen the result of a set of tests extending over 24 hours was as follows:

Date. June 5-6, 1914

Time of sampling	9.0–10.30 a.m.	10.45–11.30 a.m.	12.0–1.30 p.m.	2.0–4.0 p.m.	5.0–8.15 p.m.
Methane	34.7	35.6	36.3	34.7	33.0
Hydrogen	44.2	44.4	42.1	46.5	46.9

That is, the maximum difference in methane is 3.3 per cent. and in hydrogen 4.8 per cent. The result of analyses made of samples taken at about regular intervals of a week were:

	Methane	Hydrogen
May 5th, 1914	36.1	39.0
May 12th, 1914	34.8	43.6
May 21st, 1914	36.1	40.9
June 1st, 1914	34.1	42.7

or a maximum variation of 2 per cent. for the methane and 4.6 for the hydrogen. Looking back over the records, periods of four weeks each gave maximum variations as follows:

Methane	Hydrogen
2.0	4.6
0.8	3.2
2.7	3.1
2.6	4.7

As explained before, this gas is obtained from 300 retorts. If there is any irregularity in any particular retort it ought to be equalized by the others. As far as it is possible to make it, this is one and the same gas, yet we see a variation of over 4 per cent. in some cases.

Determination of the Variations in Natural Gas by Inspection

By study of the variations in the things themselves we can arrive at an approximate estimate of the differences in percentage in one and the same gas provided there are a sufficient number of observations. Unfortunately the information on this point is meagre, still it appears to the writer that it can be approximately determined. Referring to the analyses given for Kent gas it will be seen at once that Nos. 2, 3, 4, 5, 7 are very similar. Both from the analyses and the results in the field one cannot doubt that these are one and the same gas. The highest ethane of these is 10.8 per cent. and the lowest 7.9 per cent., or an extreme variation of 2.9 per cent. For nitrogen similarly it is 5.8 per cent. and 4.5 per cent. or a maximum difference of 1.3 per cent. The mean of the ethanes in these 5 samples is 9.3 per cent., so that the extreme variation from the mean both plus and minus is about 1.5 per cent. No. 1 is evidently different, having practically no hydrogen sulphide, and 10 per cent. more ethane than any of the group mentioned. No. 6 has over 6 per cent. more ethane than the mean of those that are close in composition. If these seven gases represented by the samples were really variations of one gas there should be intermediate percentages of ethane, not a sudden transition. It will be sufficient to prove this once as the reasoning will be similar in every case. If analyses marked Kent 1 to 7 represent not different gases but one and the same body of gas varying from 7.9 to 18.0 ethane then must it be equally likely that any percentage of ethane between those limits will be found. Take first of all the case of No. 6, with 15.7 per cent. ethane, and eliminating No. 1 for the present, the ethanes then are—(2) 10.8, (3) 8.5, (4) 7.9, (5) 10.6, (7) 8.5 and (6) 15.7. Take the highest and lowest of the group which are close together, viz.: 2 and 4, the difference between them is 2.9 per cent. Now take that as the unit and subdivide the interval between the highest and the lowest into units of this dimension. The first subdivision will take in percentages from 7.9 to 10.8, the second from 10.8 to 13.7, the third from 13.7 to 15.7 or an increase of 2 per cent. instead of 2.9. We have a total difference then of 7.8 per cent. Now by hypothesis, this being one and the same gas varying between the limits mentioned, the chance of any given analysis of this gas falling within any particular range of percentage is equal and proportional to the extent of the range, and these ranges of per cent. are expressed by the figures (1) 2.9, (2) 2.9, and (3) 2. Therefore, the chance that any given analysis will fall in the first range is represented by 2.9, in the second by 2.9, and in the third by 2, and it must fall in one of these subdivisions, and the sum of these or 7.8 represents certainty. The chance then, that any given analysis will fall in the first subdivision is 2.9 in 7.8 or 29 in 78. But we see that all five fall in this subdivision, and these are all independent events, the gas varying by hypothesis, therefore, the chance that all this series of events could happen under our hypothesis is $\left(\frac{29}{78}\right)^5 = \frac{1}{222}$.*

We must conclude then that our hypothesis is wrong and that the gas represented by No. 6 analysis is not one and the same gas, but different from 2, 3, 4, 5, 7. If this can be proved for No. 6, much more easily can it be proved for No. 1, where the differences are much greater. We must assume, therefore, that something has happened to alter the composition of the gas in these two cases. In the case of Lambton Nos. 1 and 2, which are only about 700 feet apart, and therefore, one would expect them to be the same gas, the results are not as close as in other cases of adjoining wells. The presence of propane makes the exact analysis more difficult. Neither of the gases represented by Lambton Nos. 1 and 2 show any trace of anything besides the hydrocarbons and nitrogen.

This will be noticed throughout the whole set of analyses. Almost invariably the immediately adjacent ones which might naturally be expected to be the same gas are very close in composition. Careful examination of the analyses of Ontario gases appears to indicate that about 3 per cent. is the probable variation for one and the same gas as far as the hydrocarbons and nitrogen are concerned. Before proceeding further it would be well to see how this agrees with results obtained in other gas territories.

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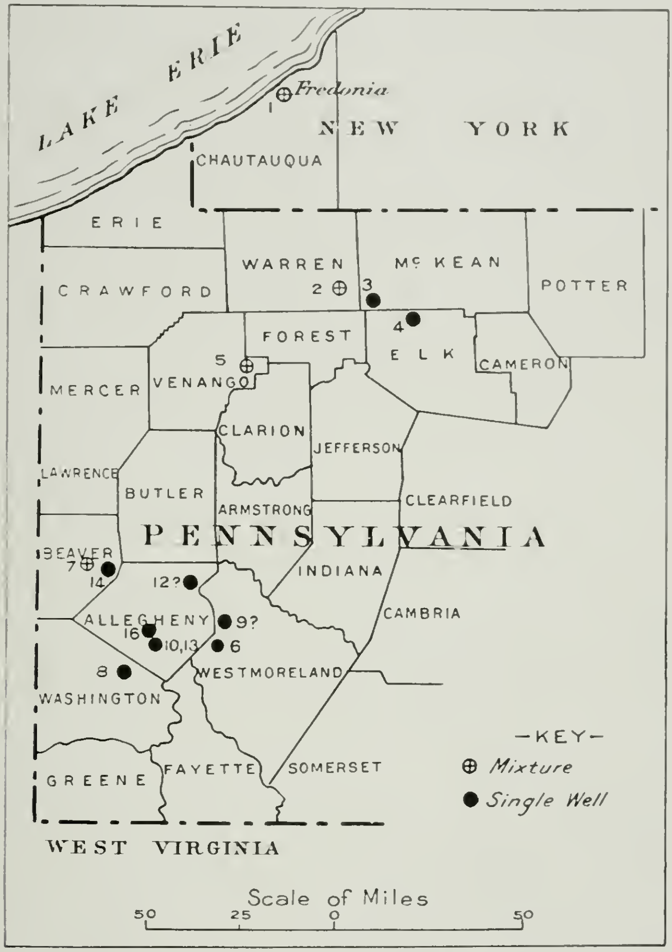
* For full explanation and proof, see Whitworth's "Choice and Chance." Pub. Deighton Bell & Co., Cambridge, Eng.



Parts of New York and Pennsylvania. From New York State Museum Map, Bulletin 160, and Pennsylvania Geol. Sur. Atlas. Position of Wells plotted from description in text of paper quoted

TABLE II.

PENNSYLVANIA GASES.*

	1	2	3	4	5	6	7	8	9	10	12	13	14	16
Carbon dioxide	.41	.30	.20	.21	.05	.28	Tr.	.44	.20	.52	3.64	.40	.41	.30
Carbon monoxide....	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethane	Given with methane, &c., as paraffins													
Hydrogen	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen sulphide ..	0	0	0	0	0	0	Tr.	0	0	0	0	0	0	0
Methane...........	Given with ethane, &c., as paraffins													
Olefines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxygen	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	0	0	0	0
Nitrogen	9.54	9.06	9.79	9.41	4.51	2.02	9.91	15.30	4.40	7.30	0	.70	12.32	7.10
Paraffins	90.05	90.64	90.01	90.38	95.44	97.70	90.09	84.26	95.40	92.18	96.36	98.90	87.27	92.60

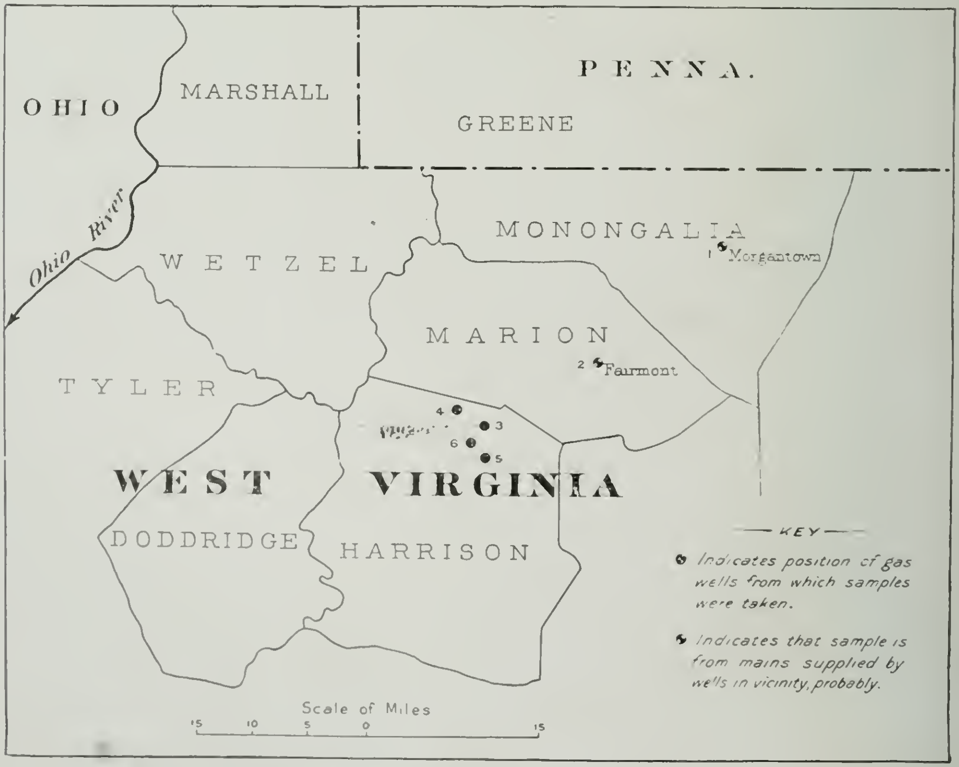
*Chemist, F. C. Phillips.—From Am. Chem. Jour., Vol. XVI.

Variations in Composition of Natural Gas in Other Fields

Pennsylvania and West Virginia

The earliest systematic work on the composition of natural gas was done by Francis C. Phillips on the gases of Pennsylvania in 1886 and published in the Geological Survey Report of that State. In 1894 this was added to and the results given are taken from the Amer. Chem. Journal, Vol. 16. The numbers used in list of analyses are as given in that Journal. It will be noticed that some of the samples were mixtures from mains and therefore not of so much value for this purpose. Too much credit cannot be given Phillips for his contributions on the composition of gas. But for his work very little would be known now.

Referring to the analyses quoted from Phillips and other authorities, for the purpose of easy comparison, the different constituents are placed uniformly in alphabetical order. Maps have also been prepared in every case to bring out the relation between variations in composition and location from which the sample was taken more clearly. The methods of analyses have changed, and Phillips does not give methane and ethane, etc., separately, but calls them all paraffins. This does not make much difference for our purpose as we wish merely to note the variations, and as the determinations have all been made in the same manner, they are comparable. Taking the nitrogen as the best indicator, it will at once be seen that 1, 2, 3, 4 are very close together, but 1 and 2 being mixtures from different wells we cannot be certain whether there were variations in some of the constituents in opposite directions or whether the gas from each of the wells was the same. However, 3 and 4 agree very closely. The only one which disagrees substantially with those in the immediate vicinity is No. 13.



Portion of West Virginia reduced from map by West Virginia Geol. Sur. Vol. V. Position of Wells plotted from description in Vol. Ia, same Survey.

TABLE III.

GASES FROM WEST VIRGINIA.*

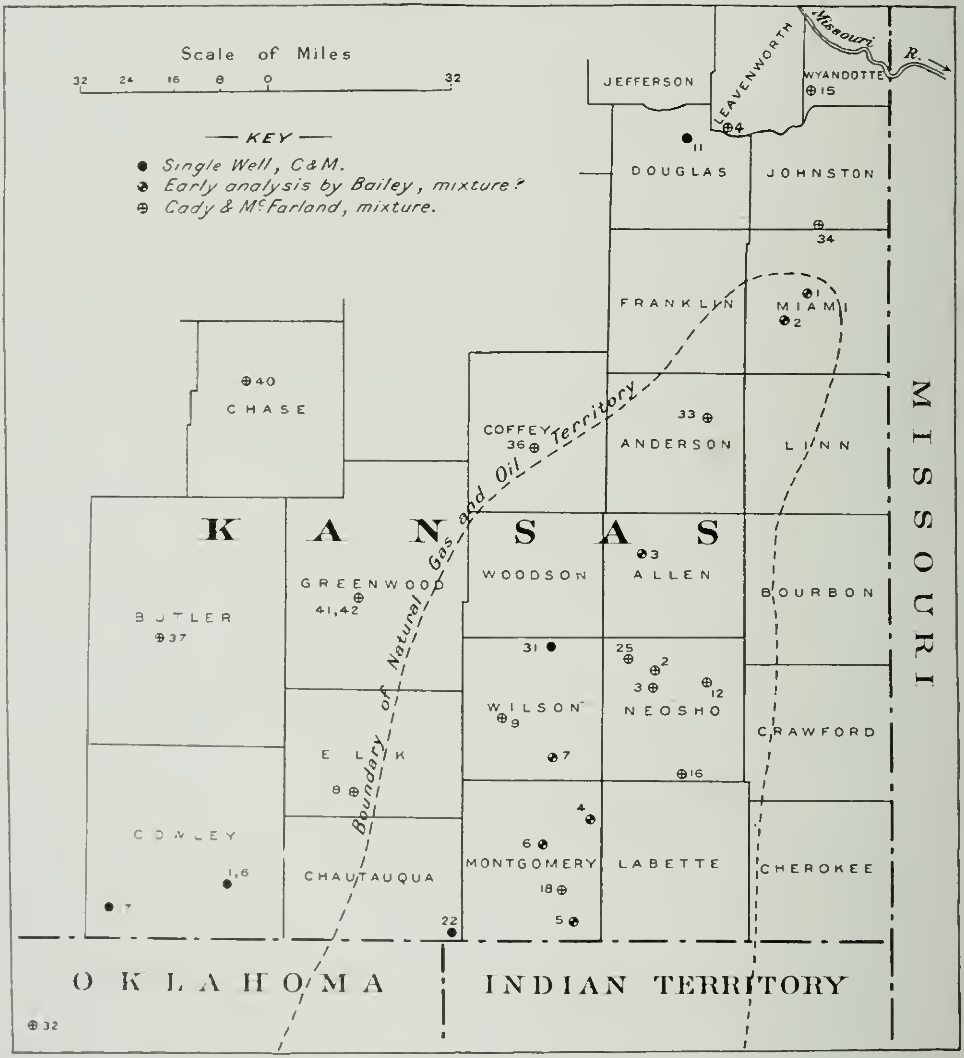
	1	2	3	4	5	6
Carbon dioxide	Tr.	.1	0	0	.1	0
Carbon monoxide	.4	.4	.4	.4	.4	.5
Ethane	14.60	14.09	15.09	14.88	14.35	7.65
Hydrogen	Tr.	.2	0	.1	.1	0
Hydrogen sulphide	0	0	0	0	0	0
Methane	80.94	81.60	79.95	80.85	80.70	86.48
Olefines	.4	.2	.4	.2	.1	.2
Oxygen	.2	.2	.2	.1	.3	.3
Nitrogen	3.46	3.21	3.96	3.47	3.95	4.87

* Chemist, C. D. Howard.—From Vol. Ia West Virginia Geol. Sur.

Coming to West Virginia it will be noticed that 1 and 2 are mixtures, No. 1 being from Greene and Monongalia Counties. Nos. 3, 4, 5, and 6 are from single wells, and of these No. 6 differs by about 7 per cent. of ethane from the rest, and therefore, probably is a different gas. The variation in the others is less than 1 per cent. with the ethane. The top of various sands from which the gas came is given as 1421, 2199, 2380 and 1855 feet below the Pittsburgh Coal for 3, 4, 5 and 6 respectively. The gas territory extends throughout Monongalia, Marion, Harrison, Doddridge, part of Tyler and Wetzel, according to the report from which these analyses are taken. The results show the same features as those quoted from Pennsylvania, viz: Either close agreement or a substantial difference and therefore probably not a variation of one and the same thing between two extremes, but two different things. The proof would be the same here as illustrated above. Taking the ethanes again in 3, 4, 5 and 6 we have a difference of over 7 per cent between 3 and 6—this can be bridged as before by units covering the extreme range of the other three. To save calculation take 1 per cent. as the interval, then all three, i.e., Nos. 3, 4, 5 fall in this interval. As before the chance of this would be $\frac{1}{7} \times \frac{1}{7} \times \frac{1}{7} = \frac{1}{343}$. Therefore, as before, probably we have two different gases, not variations in one and the same gas.

Variations in Kansas Gas

The natural gases of Kansas have been thoroughly examined by Cady and McFarland and their results given in a paper entitled "Helium in Natural Gas and the Composition of Natural Gas" published in the Journal of the American Chemical Society, Vol. 29, II, and also in the University Geological Survey of Kansas, Vol. IX. This is a most interesting and invaluable paper and contains a wealth of information. The discovery of the rare gas helium which, as far as known, is only produced by the decay of radium, in comparatively large quantities—up to 1.8 per cent.—opens up an interesting field of speculation. In addition to this a great number of analyses of widely varying gases are given. For the purpose for which this paper is referred to, as an illustration of the variations which occur, it seemed advisable to plot the locations of all the samples on a map and to outline on this map the gas territory as it appeared to exist originally, especially as the writer wished to compare two sets of analyses, one of which was made in 1895 and was confined wholly to the area explored first. The location of all the samples of gas taken from within the area outlined and analysed by Cady and McFarland is shown on the map except in the case of a few where the approximate position of the wells was not given but merely the statement made that the gas was from certain mains without indicating the position of the wells. It will be noted that there were only two wells sampled within the area out-



Part of Kansas compiled from maps in Bull. 238 and 296 U.S. Geol. Sur. and Univ. of Kansas Geol. Sur. Vol. 9. Position of wells plotted from description in text of paper quoted.

TABLE IV.

KANSAS GASES.

	Single wells in gas area as outlined.			Analyses of mixtures in area outlined											Analyses of gas within area outlined on map of Kansas reproduced.							
* Cady & McFarland, Chemists.				*Cady & McFarland, Chemists.											† E. H. S. Bailey, Chemist.							
	22	31	Aver.	2	3	9	12	16	18	21	25	33	45	Aver.	1	2	3	4	5	6	7	Aver.
Carbon dioxide..........	.81	.0	.41	0	.20	.61	.33	.72	.92	.70	0	.20	1.94	.62	0.33	0.22	0.90	0.22	.00	0.44	1.0	.44
Carbon monoxide........	0	.11	.05	0	0	0	0	0	0	.30	0	0	0	.03	.57	1.33	1.23	1.16	.91	.33	.50	.86
Ethane	0	.78	.39	0	0	0	4.26	3.37	0	0	0	.36	.75	.87	.....	.....	.....	.....	.....	.....	.....	.....
Hydrogen	0	.18	.09	0	Tr.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen Sulphide.......	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.....	.....	.....	.....	.....	.....	.....	.....
Methane	92.4	96.2	94.3	98.0	98.06	82.25	90.30	91.9	95.7	91.50	94.7	94.3	94.3	93.10	95.20	97.63	89.56	92.46	96.41	95.28	90.56	93.87
Olefines...............	.1	.0	.05	.....	.....	.12	.30	0	.61	0	0	.16	0	.16	.11	.22	0	0	.35	.67	.22	.23
Oxygen	.15	Tr.	.08	.12	Tr.	Tr.	.22	Tr.	0	.40	.10	Tr.	.24	.10	.45	Tr.	.45	.22	.12	Tr.	.65	.27
Nitrogen	6.46	2.46	4.46	1.88	1.57	16.4	4.45	3.74	2.69	6.97	4.96	4.61	2.60	4.99	2.34	.60	7.76	5.94	2.21	2.28	7.07	4.03
Helium	.08	.27	.18	.....	.17	.62	.13	0.27	.08	.13	.24	.37	.17	.24	.....	.....	.....	.....	.....	.....	.....	.....

No. 45 not shown on plan. Wells were in Allen and Neosho Cos. No. 9 Wells from 2 to 7 miles E.S. and N.W. of position indicated on plan

*From Jour. Am. Chem. Soc., Vol. 29. Part II.
† From Bull. No. 238 U.S. Geol. Sur., and Univ. Geol. Sur., Kansas, Vol. IX.

lined, but these two do not differ much from one another, nor does the mean of the two single wells vary greatly from the mean of all the mixtures within the outlined area. For example, compare 4, 5 and 6 of Bailey's with 18 of Cady and McFarland's and 22 from a single well. The extreme variation in the nitrogen in the first three mentioned is 3.73 per cent. and in the latter two 3.77. There being tremendous variations in the nitrogen in Kansas, this similarity is the more striking. As these sets of analyses were probably not made in exactly the same way, they should rather be compared with one another than with the other set in order to estimate the variations.

Calculation of the Probable Number of Dry Gases

Inspection of results of analyses available at present seems to indicate that a variation of more than 3 per cent. in any of the hydrocarbons or nitrogen and possibly 1.5 in the carbon dioxide in any two given gases makes it probable that they are different in origin or have suffered some change. We can now calculate the number of combinations possible or the number of different gases. As methane must be one of them as far as we know, and must make up the balance to 100 per cent. we can disregard it entirely in the calculation. If ethane may be present up to 27 per cent. and a difference of 3 per cent. in the ethane constitutes a different gas, then there must be nine possible different selections to be made from this constituent. In the same way two could be made from propane. Imagine now that gas could consist only of ethane and propane up to the limits mentioned along with the methane. Then, of course, each one of the nine different grades of ethane might combine with either of the two propanes and thus make 18 different gases. And any one of these 18 might be either with or without hydrogen sulphide, forming thus 36 different gases, and so on. The total number of combinations is therefore $9 \times 2 \times 15 \times 2 \times 2 \times 3$ or 3240—ethane being allotted 9 different possible grades, propane 2, nitrogen 15, hydrogen sulphide 2, helium 2 and carbon dioxide 3.

While this is the possible number of combinations, the probable number is very much less. A scrutiny of the reliable analyses published will show that the ethane and the nitrogen do not often exceed 18 per cent.; propane is probably generally absent; the same holds for hydrogen sulphide. Carbon dioxide would most frequently be only capable of classifying as high or low, while helium is so seldom determined that we might as well disregard it altogether in considering the probable combinations. The probable number of gases would then be $6 \times 6 \times 2 \times 2 = 144$. This is assuming a range up to 18 per cent. for ethane and nitrogen and that either propane or hydrogen sulphide will be present in about half the gases and that carbon dioxide is graded either as high or low, probably 1 per cent. being considered high. The chance that any two gases will coincide in composition unless they are identical in origin and belong to, or once did belong to, the same body of gas, if that term may be employed, is 1 in 144. If their position is such that it is impossible they could have a common origin then something with less than one chance in a hundred has happened, and should make one look with suspicion on the circumstance.

Probable Number of Different Gases in Ontario

Allowing the differences mentioned to exist in the same gas, it would appear that the various wells sampled should be classified as follows:

Essex 1	=1?
Kent Nos. 2, 3, 4, 5, 7, all one	=1
Kent No. 1	=1
Kent No. 6	=1
Lambton 1, 2	=1
Lambton 3	=1
Elgin No. 1	=1
Norfolk 1 and 2	=1
Haldimand 2, 3, 4, 5, 6, 7, 8, 10, 11, 12 Wentworth 1, Norfolk 3	=1
Haldimand 9	=1
Haldimand 1	=1
Brant 1	=1
Brant 2, 3	=1
Welland 1, 6 ?	=1?
Welland 2, 3, 4 ?	=1?
Welland 5	=1
Welland 7	=1
York 1	=1
Possibly only 15	18

The mean of all the ethane percentages in Haldimand, leaving out 1 and 9, is 13.7 per cent. None of them differ as much as 3 per cent. from that mean. Possibly Haldimand 7 and 8 should not be included with the others and it might be more correct not to consider Welland 1 and 6 and Welland 2, 3 and 4 as separate from the gases in Haldimand. In that case Welland 1 and 6 have been modified in some way.

GENERAL DISCUSSION OF RESULTS OF ANALYSES

Influence of Geological Formation

The analyses as far as the evidence goes do not appear to show that the geological formation in which the gas is found has any influence on the composition. In taking the samples from Welland County a special effort was made to ascertain this. Gas is found in four different rocks in that County, viz: the Clinton, average depth about 700 ft., Red Medina 765 ft., White Medina 810 ft., and Trenton. As many wells derive their gas from two or more of these sands, the drilling records were examined carefully to select wells which yielded gas in only one formation. Accordingly 1 and 2 were taken to represent the White Medina and 3 and 4 the Clinton, and 5 the Trenton. Red Medina was left for Haldimand County. But it is seen that No. 2 is similar to 3 and 4 and different from 1. Afterwards two more samples were taken in Welland—No. 6 in White Medina and 7 a mixture of Clinton and White Medina gas. If we conclude that the White Medina gas is higher in ethane than the Clinton basing that on 1 and 6, then the results of 2 are inconsistent with this. Moreover, No. 7 is lower in ethane than either of the other Clinton or White Medina gases, although it is a mixture of the two. No. 5, as explained before, is from the only well in the Trenton, consequently we cannot say whether the low ethane and nitrogen is due to the influence of the rock or its position. Coming into Haldimand, No. 1, the highest ethane.

is in White Medina; 7 and 8 are the next highest and are in Red and White Medina respectively. The lowest ethane in Haldimand is No. 9 in Red Medina, and so on—no definite differences.

In the western fields the gas is all obtained from one formation in the same field.

Influence of Declining Pressure on the Composition

In the old field of Welland-Haldimand, etc., a number of wells which are almost exhausted were sampled purposely to see if there was any difference between the low and high pressure wells. The viscosity of a gas, or the measure of the difficulty with which it flows through an orifice of any kind, is supposed to vary directly with the square of the specific gravity, that is, the one with the higher density would find its way less readily through the pores and consequently we should expect the low specific gravity constituents to escape first, and, therefore, there would be a concentration of the higher density gases in wells that are nearly exhausted. Taking the specific gravities of the gases constituting natural gas, and it will be sufficient to use approximations. We have 0.6 for methane, 1.0 for ethane, 1.0 for nitrogen, and 1.5 for carbon dioxide; then the square of methane density is .36 and carbon dioxide 2.25 or methane should escape about six times as readily as carbon dioxide. Hence there should be a concentration of carbon dioxide in an old well. Unfortunately this latter gas which would be our best indicator is practically absent in the Ontario gases. Welland No. 5 is the only one in the eastern part showing more than a trace. Since this well has experienced the greatest drop in pressure of all—from 1,000 lbs. to less than 100—we should expect to see it higher in carbon dioxide, as indeed, it is, and also, higher in ethane and nitrogen. Actually it is lower in these latter two than any other of the gases in that vicinity. A careful scrutiny of the list of analyses of gas from Haldimand will show that there is no apparent concentration of ethane and nitrogen in the nearly exhausted wells. Of course we have no proof that all of them are not higher in these two gases than they were originally. This brings us back to the necessity of systematic sampling of the wells in any given field at different periods of its productive life if we are to acquire a complete knowledge of the composition. This was explained fully above.

Uniformity of Composition of Natural Gas in Ontario

The most striking feature in the whole set of analyses is the wonderful uniformity of the gas derived from widely separated, and as far as the information from drilling goes, totally disconnected areas. For instance, the sample from the small field in Elgin which is 80 miles from the Kent field is almost identical with the normal gas from the latter area, the ethane being only 1.5 per cent. higher than the mean of normal Kent gas, and the nitrogen agreeing within .1 per cent. If a dash of hydrogen sulphide were added to this gas it would agree exactly with the Kent product, or conversely remove that fraction of one per cent. from the Kent and Essex gas and all these three would agree. Yet Kent is separated from Essex by twenty miles and Elgin from Kent by eighty. By the addition or subtraction of a very few per cent. of one or more constituents most of the apparently quite separate areas would be yielding the same gas. The almost complete absence of carbon dioxide in the Ontario gases is peculiar, only one sample in all the 27 examined from Elgin eastwards showing the small quantity of .15 per cent. and one a few hundredths of a per cent. An examination of the analyses quoted from other territories shows that carbon dioxide is more often present than not. When we consider that there are more than a hundred ways in which two dry commercial gases can differ and only one in which they can agree, this uniformity is surprising. It seems to be incompatible with a local and separate origin for each field. We can understand why the oxygen and nitrogen of the atmosphere are found in constant proportions in all parts of the world. There is only one atmosphere. Those who have theories to defend may be left to adjust them to the observed facts.

Surface Gas

The occurrence of gas in the drift in many places in Ontario is of both economic and scientific interest. Analyses are given of this kind of gas from two different localities in Kent County and one in York. In one place as explained above, this gas has been in use for 21 years in several houses and shows no manifest sign of diminution. To form some idea of the quantity this involves the writer secured through the kindness of the Union Natural Gas Company which has a number of pipe lines traversing the County of Kent, an estimate of the average amount of gas consumed by a household in the territory they serve. Twenty farm houses were taken at random and the average amount of gas they use per year was ascertained. The price paid there is 15 cents per thousand feet and the average consumption is 220,000 ft. per year per household. In the County of Welland similar figures were obtained from the Provincial Natural Gas and Fuel Company, the average consumption per household came to 102,000 cu. ft. per year, the price of gas being 30 cents per thousand. There is no climatic or other reason except the price why the consumption should be higher in one place than the other. It is certain that households using gas which costs nothing will not consume less. The quantity is more likely to be 300,000 ft. per year or more, so that the total amount consumed by one of these houses in 21 years is probably 6 million feet or more.

All these gases examined contained over 80 per cent. methane and therefore probably have a calorific value of over 800 B.T.U. per cubic foot, methane having over 1000. The cheapest artificial gas sold in Ontario is in Toronto, where the price is 70 cents per thousand for a gas with a heat value of about 600 B.T.U. If one were buying this natural gas on the same basis, the price should be about 90 cents per thousand. It would no doubt be considered a boon in many houses if it could be delivered into the country at that price. A value of 50 cents per thousand could reasonably be put on this natural gas. This is equivalent to $500 per million, so that the value to the households of the 6 million feet used is not less than $3,000. As explained already, several farms in Howard Tp. have used this gas. There are also some in other parts of Kent County. The probabilities must be strong that there are a number of places in Scarboro Tp. also where a supply of gas could be obtained from the drift for years sufficient for individual houses provided reasonable economy is employed.

Effect of Water on Natural Gas

As natural gas might come in contact with water in the drift, the possible effect of this on the composition should be considered. The facts given below are taken from Landolt u. Boernstein's Tabellen 4ten Auflage, and show the solubility of the various constituents of natural gas in water at various temperatures from 0° to 20° C. or 32° to 68°F. The amounts given are the number of volumes of the different gases soluble in one volume of water at different temperatures.

	0	5	10	20°
Oxygen	.0489	.0428	.038	.031
Nitrogen	.0239	.0215	.019	.016
Carbon dioxide	1.713	1.424	1.194	0.878
Methane	.055	.048	.042	.033
Ethane	.099	.080	.066	.047
Hydrogen sulphide	4.686	4.063	3.520	2.672

It is seen at once that carbon dioxide and hydrogen sulphide are vastly more soluble than the other constituents of natural gas, which do not differ greatly in this respect and consequently water could not change their relative proportions materially. Water saturated with carbon dioxide at a temperature just above zero should release some of this in percolating downwards owing to rise of temperature. Consequently if drift gas comes in contact with water we must expect carbon dioxide.

Oxygen in Water and Natural Gas

The behavior of oxygen in water may throw some light on the absence of this constituent in natural gas. Thorpe's Dictionary of Applied Chemistry under "Water" gives the amounts of nitrogen, oxygen and carbon dioxide present in rain water as 1.308, 0.637 and 0.128 per cent. respectively, and in discussing drinking waters it is said: "The gases present in ordinary drinking waters are those of the atmosphere, oxygen, nitrogen and carbonic anhydride (carbon dioxide). Their quantitative determination is rarely made as they are of little or no significance in connection with the quality of water for drinking, excepting that through the absence of the dissolved gases a water has the flat taste of that which has been recently boiled. It is sometimes supposed that the absence of a due proportion of dissolved oxygen in water is an indication of the presence of decomposing organic substances, but this can only be the case with surface waters, as the very purest subterranean waters are almost destitute of it." The purest waters are those that have percolated most, the oxygen being so active attacks different compounds in the soil and is eliminated. If it is thus removed from water it seems likely that even if there were oxygen in gas when it is formed it would be removed in the same way.

Relation of Surface Gas to the Deep Rock Gas

Whether this "surface" gas has escaped from below or been formed in the drift, its composition is worth investigation. If it comes from below, unless it can be shown that the composition could be altered in some way there should be an agreement. As pointed out already in the discussion of the deep rock gases, there does not appear to be any reason why we should believe that the differences in specific gravity of the various constituents of natural gas have caused a concentration of the higher density ones. As has been explained already, evidence on this point is not complete and definite. An effort was made by the writer to secure samples of "surface" gas over known gas producing rock, but unsuccessfully. According to the drillers, gas is found in the drift frequently in drilling in the Kent field, possibly something like one-third of the wells showing it. At the time the samples were being collected none was available.

Influence of Drift or Surface Gas on Theories of Origin of Natural Gas

It is evident on reading the literature in connection with natural gas that the existence of a combustible substance in the drift in many places has profoundly influenced the course of thought on this subject. The method of reasoning is plain and convincing. The formation of marsh gas in swamps, or wherever vegetable matter decomposes under water, is familiar to every one. Add to this the existence of gas in the drift ascribed naturally to the decomposition of the vegetable or animal matter covered by the drift. With this simple process before our eyes why seek further for an explanation of the origin of the normal deep rock gases? Turning to our list of analyses given there are three of surface gases and thirty-nine of the deep rock product. It will be noticed at once that every one of the deep gases contains ethane while all the drift gases are entirely free of it. This might be chance of course, and we cannot prove that it is not, but the degree of probability can be determined and it will be worth while to calculate this chance and express it definitely in figures. It can readily be done in this way. Let it be assumed that all these gases represented by the 42 analyses and found in the same territory were formed in the same way out of the same things. Then must they consist of the same things. It is obvious that unless they do there is no point in mentioning the existence of drift or surface gas in connection with ordinary natural gas. Now we have seen already that the analyses given of the deep gases represent probably at least 15 different gases, and of course, it is obvious that it is the number of different deep gases which is of importance here as even an infinite number of analyses of one and the same gas could not affect the argument. We have then 18 gases in all, of which 15 have already been shown to be probably different, and the three surface gases from their position must clearly be separate bodies of gas and, therefore, the formation or determination of their constituents must have been caused by independent events. Now, as there are three gases out of the 18 which have no ethane, and these gases being all the same in origin by hypothesis, the chance that any given gas will not contain ethane is 3 in 18, or 1 in 6, or $\frac{1}{6}$ The chance that all three surface gases would be devoid of ethane is, therefore $\frac{1}{6} \times \frac{1}{6} \times \frac{1}{6}$, or $\left(\frac{1}{6}\right)^3 = \frac{1}{216}$, these being as we have seen all independent events. The mathematical proof of this is fully dealt with in Whitworth's "Choice and Chance," already referred to in a chapter dealing with series of concurrent events. Now the chance that any given one of our eighteen different gases under consideration will contain ethane, is, of course, $\frac{15}{18}$ or $\frac{5}{6}$, and the chance that all our fifteen deep gases will have ethane is $\left(\frac{5}{6}\right)^{15} = \frac{1}{15}$ approximately. Therefore, the chance that the whole series of events would happen as it did, is, under our hypothesis, $\frac{1}{216} \times \frac{1}{15} = \frac{1}{3240}$. But the events did occur, therefore the amount just found represents the chance that the hypothesis is right.

The nature or composition of surface gas being such an important link in the chain of reasoning regarding the origin of natural gas it is surprising that no analyses are given in support of the theories. The authorities have decided how it is made before ascertaining what it is. And yet, it seems more logical to find out first the thing which is capable of accurate determination. If we know what natural gas is we are more likely to arrive at a correct idea of how it was made. The writer has only been able to find two analyses of gas from the drift in literature. Both of these are in Cady and McFarland's admirable and elaborate review of analyses of natural gas.[1] One of these is not expressly stated to be drift gas, but from the description probably is, as it is recorded that the gas was obtained from a pipe driven down 210 feet through clay. An analysis by Dr. Rollin Chamberlin of a sample obtained at Princeton, Ill., follows:[2]

Carbon dioxide	0.10
Carbon monoxide	0.05
Oxygen	0.05
Methane	13.97
Nitrogen	85.83
	100.00

Compare with the analysis given below of a similar high nitrogen gas from Dexter, Kansas, with 1 per cent. ethane and also 1.6 helium. The ethane is small here; with over 80 per cent. nitrogen there is not much room for anything else. The other analysis is of a drift gas from Dawson, Iowa, quoted by the above mentioned authors from Eighth Ann. Rep. Iowa, Geol. Survey:

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[1] University Geol. Sur. of Kansas, Vol. IX.

[2] Ibid, pages 251-2.

Hydrocarbons and nitrogen	95.35
Carbon monoxide	2.50
Carbon dioxide	1.60
Oxygen	0.55
	100.00

This is an entirely useless result for any purpose whatever. If it is intended to show the fuel value it makes quite a difference how much nitrogen there is. It looks as if the three constituents mentioned last in the analysis had been determined and the rest is by difference. The only constituent we can rely on as probably correct is the carbon dioxide. This analysis is fairly typical of the amount of intelligent attention that has been devoted to the composition of drift gas. Of course, our old friend Oxygen must be in it too. There is a real significance in this. It has already been shown in the description of mode of sampling that the diffusion of air and gas in the holder is not according to theory at all. If we are unable to forecast what will take place in an insignificant tube that can be held in the hand where only one operation is involved, what chance is there that we can decide on what has taken place over hundreds of square miles, and where more than one operation is concerned? Yet the analysis will show within a few hundredths of a per cent. how much oxygen is in the tube and consequently to what extent the theory of diffusion has failed. And so, on the larger scale, it is possible to determine after a while exactly what the composition of gas is. Whether it is of organic or inorganic origin, and it must be one of the two, or both combined, it must have been made by chemical processes which have produced the resultant gas. An accurate knowledge of the composition of this resultant cannot fail to aid in arriving at a correct conclusion with regard to origin. At any rate, it will weed out some of the theories proposed which will be a benefit and we will have the satisfaction of having made an intelligent effort to solve the mystery.

Miscellaneous Analyses of Natural Gas

There is very little satisfaction in studying lists of analyses of natural gas available at the present time. Sufficient care is generally not taken with one or more o following factors, viz., with regard to selection of place from which the sample is taken, or mode of taking it, or method of analysis. All due to the fact that the authorities on natural gas have attached very slight importance to the composition. There is little to be gained from comparing results obtained in a different way. Accordingly only a few are produced below for illustration:

Kansas Gas

Analysis No. 11, Cady & McFarland, Kansas gas shown on plan.

Carbon dioxide	0.20
Carbon monoxide	0.00
Ethane	.00
Methane	51.80
Nitrogen	46.40
Helium	1.50
Oxygen	.10
	100.00

Wyoming Gas

Gas from Greybull, Wyoming (A. G. Burrell, Analyst), Technical Paper No. 57. U.S. Bureau of Mines.

Carbon dioxide	0.20
Ethane	17.35
Methane	81.70
Nitrogen	0.75
	100.00

The well drilled at Kissarmas in Hungary is most interesting. This was started in the hope of finding potassium salts. A full account is given in a report published by the Hungarian Finance Ministry. "Bericht Ueber die Resultate der bisher zur Erforschung der Erdgasvorkommen des Siebenbuerger Beckens vorgenommenen Unterschungen," Budapest. 1911. Franz Boehm, the Engineer under whose direction the work was carried out, gives the following details:

Work started 26th Nov., 1908.
Small amount gas found at 70 ft.
Larger amount gas found at 376 ft.
Strong flow at 680 ft. (30th Jan., 1909.)

The pressure was then 450 lbs. (30 atmos.) and the capacity 3,100,000 cubic feet in 24 hours. An analysis of the gas at this time by Prof. Ignaz Pfeifer showed 99.25 per cent. methane and .75 nitrogen. The well was continued to a depth of 993 feet, when the pressure was 750 lbs. An analysis of the gas by Prof. Schelle at this stage gave:

Methane	99.0
Nitrogen	0.2
Hydrogen	0.4
Oxygen	0.4

Well stopped April 22nd, 1909. Capacity at this time 32,000,000 feet.

The rocks in which gas was found were clayey marls and sandstones of the Miocene age. They were unable to close the well for some time and gas was wasting for 2½ years. (Jour. für Gasbeleuchtung Nr. 51 S 1251 Münnchen).

Gas From Russia

Baku, Russia

Hydrogen	0.98
Methane	93.09
Ethane	3.26
Carbon dioxide	2.18
Nitrogen	0.49
	100.00

The analysis is from Lewes "Liquid & Gaseous Fuels," p. 46, chemist not known.

Examples of Analyses of Natural Gas Showing Oxygen

In boring for water at Neuengamme near Hamburg, Germany, gas was found at a depth of 808 ft. Analysis No. 1 of this gas is by the Hamburg Hygienic Institute. No. 2, which was taken 23 days later, was by the Hamburg Gas Works.[1]

Neuengamme, near Hamburg

	1	2
Methane	91.5	91.6
Olefines	2.1	0.8
Nitrogen	5.6	4.4
Oxygen	1.5	0.7
Carbon dioxide	0.3	0.2 also H_2S.
Hydrogen		2.3
	101.0	100.0

Helium .01—.02 per cent.

Gas from Smithfield, Utah.[2]
Prof. Kingsbury, Chemist

Carbon dioxide	.8
Carbon monoxide	1.2
Ethane	37.8
Hydrogen	16.6
Methane	22.3
Olefines	0.7
Oxygen	0.9
Nitrogen	19.7

Pittsfield Gas, Pike Co., Ill.[3]
(Chemist not given)

Carbon dioxide	.81
Oxygen	3.46
Methane	73.81
Nitrogen	21.92
	100.00

This list could be indefinitely extended.

Analyses Illustrating Composition of Gas from Oil Wells and "Wet" Gases

The following analyses are taken from Technical Paper No. 57, U. S. Bureau of Mines. A. G. Burrell, analyst.

	Oil Well at Byron, Wyoming	Salt Creek Field, Wyoming
Carbon dioxide	= 0.47	.0
Methane	=64.05	.0
Ethane	=32.28	60.40
Propane	....	10.63
Nitrogen	= 3.20	28.97
	100.00	100.00

In Bulletin 42 loc. cit., A. G. Burrell gives analyses of "wet" gases showing the following maxima:

For propane, 88.3 per cent.

For ethane, 96.1 per cent.

For butane, 40.6 per cent.

Methane is sometimes entirely absent.

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[1] Translated from "Ueber den Helium und Argongehalt des Erdgases von Neuengamme" by A. Voller und B. Walter, Jahrbuch der Hamburgischen Wissen-Schaftlichen Anstalten XXVIII, 1910.

[2] From Bull. 260, U. S. Geol. Sur., p. 481.

[3] From Illinois State Geol. Sur. Bull. 2, p. 82.

Incombustible Natural Gases

The following analyses are by Cady & McFarland. (Position shown on plan.)

	No. 1	No. 6
Carbon dioxide	0.	0.
Carbon monoxide	0.	0.
Ethane	0.41	1.06
Hydrogen	tr.	tr.
Methane	14.85	14.33
Olefines	0.	0.
Oxygen	0.2	0.1
Nitrogen	82.70	82.87
Helium	1.84	1.64
	100.00	100.00

Burrell states that he has found 98 per cent. of nitrogen in a natural gas from Washington and 30 per cent. of carbon dioxide in California gas. (Journ. Ind. Eng. Chem. Vol. 4, 1912, p. 615). It is evident that if the "wet" gases and the incombustible ones were considered. the total number of gases must be vastly greater than calculated above.

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REPORT OF THE ONTARIO BUREAU OF MINES,
VOL. XXIII, PART 2

The Kirkland Lake and Swastika Gold Areas

AND

MAISONVILLE, GRENFELL AND EBY TOWNSHIPS

BY

A. G. BURROWS and PERCY E. HOPKINS

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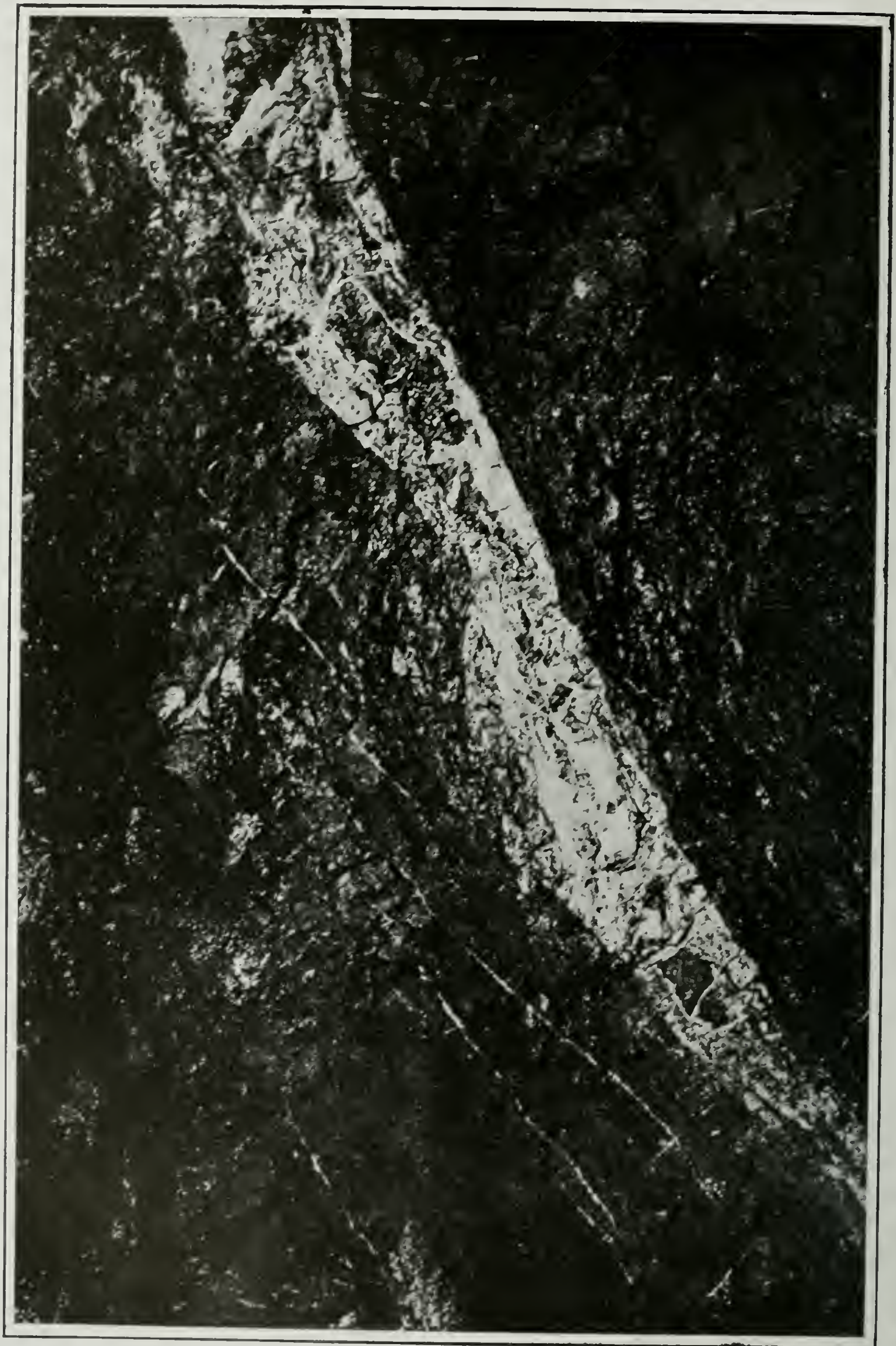
MAPS

Kirkland Lake and Swastika Gold Areas (Map No. 23a). Scale, ¾ mile to 1 inch. Geologically colored.

Maisonville, Grenfell and Eby (Map No. 23b). Scale, ¾ mile to 1 inch. Geologically colored.



Tough-Oakes Mine, No. 3 vein as exposed on the east side of the shaft between depths of 61 and 67 feet. The vein is in the porphyry, the fractured character of which is shown in the illustration.

THE KIRKLAND LAKE AND SWASTIKA GOLD AREAS

By A. G. Burrows and P. E. Hopkins.

The Kirkland Lake and Swastika Gold Areas are in the district of Timiskaming, about fifty miles north of Cobalt. As shown by the accompanying map, the main line of the Timiskaming and Northern Ontario railway runs through the southwestern portion of the areas. A small town has sprung up at Swastika station, at mileage 164, where the railway crosses the Blanche river. A good wagon road has been constructed by the Ontario Government from the town in a northeasterly direction to the Tough-Oakes mine, a distance of about seven miles. This road passes by the south shore of Kirkland lake. Swastika station by rail is 390 miles north of Toronto.

The areas which have been mapped include the townships of Otto, Teck, Lebel, Boston, McElroy and Gauthier (Map No. 23a). Portions of McElroy, Gauthier and Boston were not examined.

During part of 1911 Mr. E. L. Bruce examined an area in the vicinity of Swastika in which are situated the Swastika and Lucky Cross mines. In 1912 and 1913 further geological work was done, special attention being given in 1913 to the region around Kirkland lake, where numerous gold-bearing quartz veins had been discovered. A great part of the area around Swastika and eastward to Larder lake was staked during the rush into Larder lake in 1906, in the boom days of Cobalt. Most of these claims were, however, abandoned before much work had been done.

Gold was first found in a vein on the north shore of Otto lake on a claim which is now part of the Swastika mine group. In 1911 the metal was discovered in several veins to the north of the railroad and just east of Amikougami creek. These discoveries were later developed by the Lucky Cross Mining Company. Beyond these two properties there has been little development in the Swastika area apart from prospecting on a number of claims. The claims which were staked in the Larder lake rush and abandoned have been restaked, and important gold discoveries made. The first discovery in the Kirkland Lake area was on the Wright-Hargrave claim to the east of the lake. Gold was found in the quartz veinlets which traverse the reddish feldspar-porphyry. In January, 1912, gold-bearing veins were found in the porphyry and the conglomerate on the Tough-Oakes claims, three-quarters of a mile northeast of Kirkland lake. However, very little interest was taken in the Kirkland lake area in 1912, but the development of No. 2 vein of the Tough-Oakes group and the shipment of high-grade gold ore from this property caused great interest in the area in 1913, and much surface trenching resulted in the finding of a number of promising veins. During the year a number of shafts were sunk and some drifting done on certain veins.

The areas are situated just south of the height of land between the Hudson Bay and the St. Lawrence River waters. The altitude on the average is about 1,050 feet. The station at Swastika is 1,007 feet above sea level. The hills are seldom more than 100 feet above the surrounding country. Very little of the country is suitable for agriculture, as rock exposures are abundant or concealed by sand plains or swamps. Generally speaking, the timber is small, since a great part of the area was burned over about fifty years ago. Charred stubs of the old forest are frequently seen, indicating an old red and white pine forest with large sized trees. The present timber is spruce, pitch pine, birch, poplar, balm of Gilead, balsam and cedar. The rocky ridges are clothed with scrubby pitch pine, while in some of the lower parts, where there is more or less soil, there are spruce and poplar trees of considerable size. This fair-sized timber is utilized for building and mine purposes. Sand plains and rolling sand ridges with a growth of pitch pine are characteristic of a great part of Gauthier township south of Victoria lake. The country is drained by the Blanche river, and its tributaries, which flows southward, finally emptying into Lake Timiskaming. There are several clear water lakes in the area, the largest of which is Round lake. Some of the smaller lakes, such as Amikougami, Gull and Kirkland, are quite picturesque. These lakes contain the usual pike and pickerel so common in northern waters, while lake trout are plentiful in Crystal lake, a beautifully clear water lake in Lebel township.

Previous Exploration of the Region

The first description of this area was given by Mr. W. J. Wilson, who, in 1901[1] made a reconnaissance survey of the Blanche river for the Geological Survey of Canada.

In the Eleventh Report of the Bureau of Mines[2] Dr. W. G. Miller described a part of the area. The geology of the northeast branch of the Blanche river through the townships of McElroy and Gauthier is described, as is also that of Beaverhouse lake and Victoria lake, the latter being called Quasis lake.

Scene on Amikougami lake showing glaciated island with drift removed from N.E. end.

In 1902[3] Mr. L. L. Bolton, acting as geologist with O. L. S. Speight's survey party, gave a description of the geological and other features of an area from Round to Abitibi lakes. Mr. Bolton followed the water route, so that his information is necessarily confined to a narrow stretch of country. He gives a description of rocks along the Blanche river, which flows from Sesekinika and Kenogami lakes, and also of the portage route from Sesekinika lake to Amikougami lake. In Bolton's report Amikougami lake is called Lake Anikojigami, which name implies "a collection of lakes joined by narrow passages."

In the Fourteenth Report of the Bureau of Mines[4] W. G. Miller described the geology of a portion of the township of Boston, in which an iron range had been discovered a few years previous: "The iron formation or jaspilyte of Boston is similar in character to that of Temagami and to those of other parts of Ontario such as the Hutton township range north of Sudbury, and the Vermilion range of the state of Minnesota." Other formations referred to are the greenstones, syenites, conglomerate and later trap dikes, which are shown on the accompanying map.

---

[1] Geol. Survey of Canada, Vol. XIV, 117A to 130A.
[2] "Lake Temiskaming to the Height of Land." 11th Report, Bureau of Mines.
[3] "Round Lake to Abitibi." 12th Report, Bureau of Mines.
[4] "Boston Township Iron Ranges." 14th Report, Bureau of Mines.

Scene on Blanche river, McElroy township.

Scene on Kirkland lake.

Geology

The rocks of the area may be classified as follows:

Glacial and Recent

Stratified clay, sand, gravel and other material

Pre-Cambrian

LATER DIKES ....Diabase
(*Intrusive contact*)

COBALT SERIES ....Conglomerate
(*Unconformity*)

POST-TIMISKAMING INTRUSIVES { Granite, syenite, feldspar-porphyry.
(*Intrusive contact*)
Lamprophyre.
(*Intrusive contact*)

TIMISKAMING SERIES Quartzite, greywacké, conglomerate, with schistose derivatives.
(*Unconformity*)

KEEWATIN Greenstone (basalt, andesite, etc.), diabase, quartz-porphyry, feldspar-porphyry, iron formation, dolomite.

In the following notes are given descriptions of the various groups of rocks:

KEEWATIN

Of the rocks of the area those of the Keewatin system have the widest distribution, and they are usually of the greenstone type, either massive or schistose. Where massive they are of a pale greenish color on the weathered surface and, especially when accompanied by the ellipsoidal or amygdaloidal structure, are readily recognized in the field. There is a large volume of greenstone in the vicinity of Amikougami lake and also along the T. & N. O. railway southeasterly from Swastika as far as Boston creek. At places in the latter area the greenstone is intruded by syenite and lamprophyre dikes. The greenstones are sometimes quite schistose and rusty in appearance. Since some of the fine-grained rocks of the Timiskaming series are also schistose, it has been found difficult to distinctly classify certain rocks when occurring near the contact of the Timiskaming and Keewatin.

In the fresher samples of fine-grained greenstone a basaltic texture can be observed showing rods of plagioclase set in a groundmass of pyroxene or hornblende, which is generally altered to chlorite.

What is believed to be the spherulitic structure in greenstone was observed on the north shore of Doig lake in the north part of Lebel township. This structure is indicated by small raised and rounded masses which are lighter in color than the surrounding rock. Some of these are over an inch in diameter. They differ quite distinctly from the ordinary quartz and calcite amygdules so frequently observed. They are grouped quite thickly along the ellipsoids of the greenstone.

The broad areas of massive greenish basalt are not likely to be of much economic importance, but where shear zones occur, and the rocks have been rendered schistose, impregnated with secondary solutions and intruded by light-colored rocks, they are worthy of prospecting for gold-bearing veins.

Scene on Blanche river, McElroy township, showing rocky bluff on right, 150 feet high

Scene on Amikougami lake. Hill of Keewatin basalt in back ground, rising to 400 feet above lake level.

The chemical composition of certain Keewatin rocks is shown in the following table. They are typical rocks from Amikougami lake.

	1. Per cent.	2. Per cent.
Silica	48.70	53.90
Alumina	15.21	19.67
Ferrous oxide	8.35	10.21
Ferric oxide	4.28	0.71
Lime	11.11	8.30
Magnesia	3.76	0.72
Soda	3.23	2.78
Potash	0.59	0.58
Carbon dioxide	2.25	0.86
Water	0.65	1.80
Manganous oxide	.....	0.32

1. Ellipsoidal greenstone (basalt) 15 chains west of III mile post, north line of Teck township.

2. Amygdaloidal greenstone (basalt), Amikougami lake, 15 chains north of III mile post, north line of Teck township. This rock also shows an ellipsoidal structure.

Keewatin Diabase

Diabase, occurring as dikes and broad masses, intrudes the fine-grained greenstone at many places. This rock is generally less fresh-looking than the Nipissing diabase of Cobalt, but occasionally is mistaken for this much younger basic rock. It is often light green in color and coarse in grain like gabbro, while the original constituents are usually altered to secondary minerals. There is a large volume of this rock around Amikougami lake and throughout the Keewatin areas in the north part of Teck and Lebel. Some dikes of diabase are also seen on Otto lake. The rock is pre-Timiskaming in age, since an unconformity was observed on mining claim L. 1824 on the south shore of the northwest bay of Kirkland lake. Fragments of the diabase were found as pebbles in the Timiskaming conglomerate that rests on the diabase.

Feldspar-porphyry

A grey feldspar-porphyry to the east of Murdock creek in Teck township has been placed in the Keewatin. This rock has been described by Mr. E. L. Bruce as follows: "The feldspar phenocrysts show distinctly on the surface. Under the microscope the rock is distinctly porphyritic. The phenocrysts are plagioclase feldspar near the albite end, set in a groundmass of quartz, feldspar and hornblende. Considerable alteration has taken place, producing chlorite, sericite, kaolin, carbonates and epidote. Magnetite and chalcopyrite are present. The phenocrysts make up a large part of the rock, the areas of groundmass being narrow.

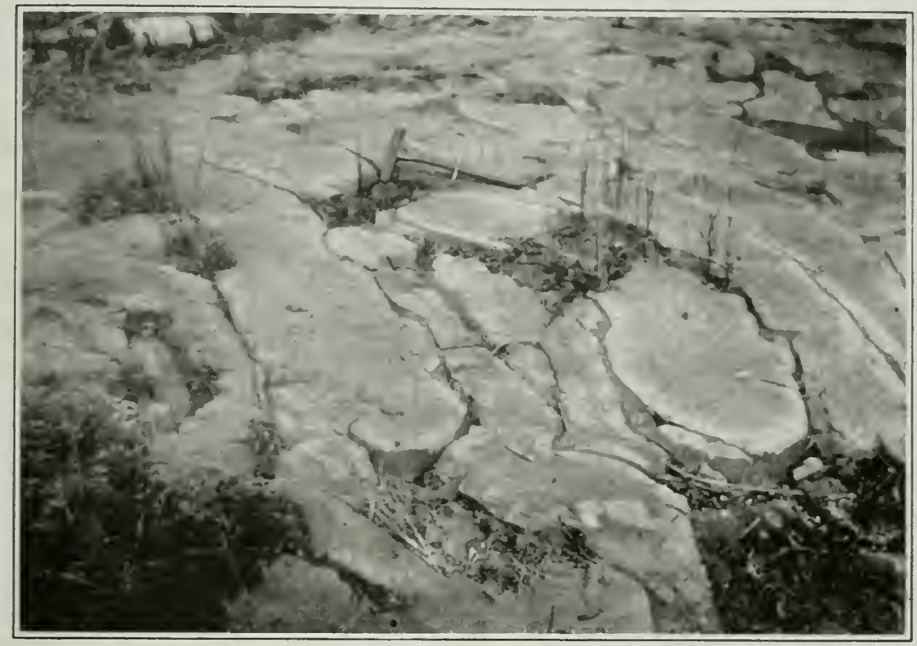
"An analysis of this rock gave: Silica, 60.71; alumina, 14.87; ferric oxide, 3.26; ferrous oxide, 3.60; magnesia, 3.52; lime, 3.29; potash, 2.52; soda, 4.40; carbon dioxide, 1.68; water, 2.35.

"This calculates to a norm consisting of: Quartz, 17.34; orthoclase, 11.10; albite, 37.16; anorthite, 1.67; magnetite, 1.20; chlorite, 12.93; kaolin, 4.82; sericite, 3.14; hornblende, 7.70.

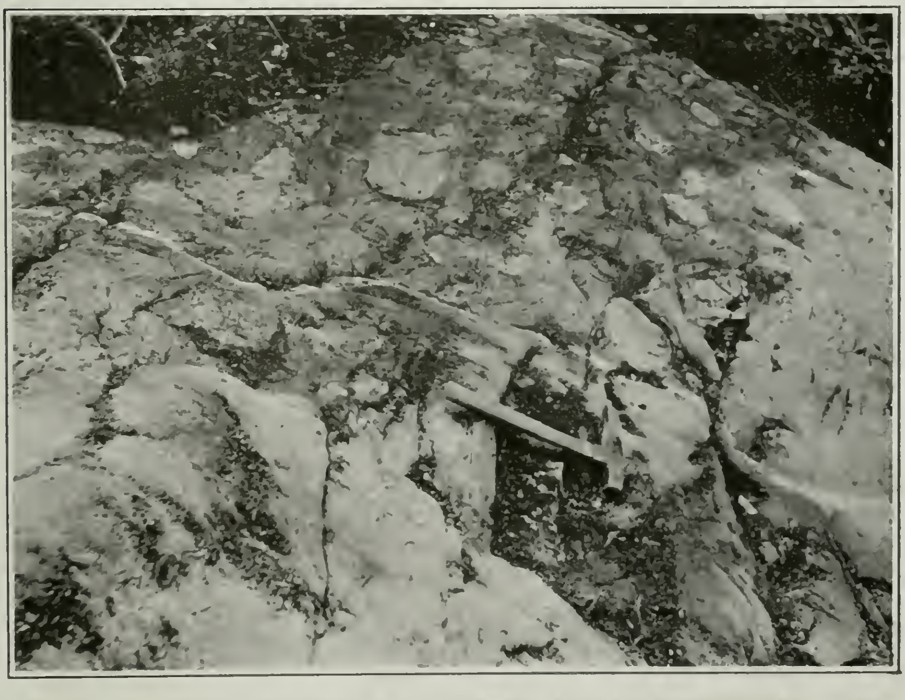
"This shows the acidic nature of the feldspar. The large quantity of chlorite present explains the rather high percentage of water in the analysis."

This rock was not observed in contact with the Timiskaming series. It may possibly be later than the Timiskaming, but, owing to its rather schistose character, it is placed with the Keewatin tentatively.

The conglomerate of the Timiskaming series contains numerous pebbles of feldspar-porphyry, derived from pre-existing rocks of Keewatin or Laurentian age. These porphyries were therefore much older than those in the vicinity of Kirkland lake, which are younger than the rocks of the Timiskaming series.



Ellipsoidal greenstone, Amikougami lake.



Unconformity between conglomerate of the Timiskaming series and Keewatin diabase Claim L 1824 Kirkland lake.

Quartz-feldspar porphyry

There are some outcrops of quartz-feldspar porphyry (granite porphyry) which have been grouped with the Keewatin. This porphyry occurs chiefly around Goodfish lake and to the south of this lake. The rock has a grey color and a whitish weathering surface in which quartz phenocrysts are quite conspicuous. The porphyry intrudes the greenstone, but is older than the Timiskaming conglomerate, since there are pebbles of the porphyry in the conglomerate on the north shore of Gami lake. This conglomerate is isolated from the main area of Timiskaming rocks but is considered to be part of the series. The porphyry is somewhat schistose, like other members of the Keewatin, and is similar to certain porphyries described in the Porcupine gold area. It is an older rock than the reddish and greyish feldspar-porphyry found near the Tough-Oakes mine. Under the microscope the phenocrysts of quartz are much corroded, with rounded angles, while the feldspar is a plagioclase near the albite end of the series. The feldspar phenocrysts are greatly in excess of the quartz. The groundmass is quite felsitic. South of Gami lake the porphyry is much darker and finer-grained than to the north, but small eyes of clear dark-colored quartz aid in recognizing the rock.

Dolomite

Ferruginous dolomite occurs in narrow bands in different parts of the Keewatin areas. This rock is quite prominent in the southeast part of Gauthier township, where several pits and shafts have been sunk in prospecting for gold. A striking occurrence of the dolomite can be seen on mining claim L. 1065 on the north side of the Dane-Larder lake road. The rock in places is greatly intersected by quartz and carbonate veinlets and contains the bright green chrome mica (fuchsite).

Iron formation

Members of the iron formation occur in isolated parts of the area. At points along the railway, between Swastika and the granite area south of Boston creek, there are bands of iron formation, represented chiefly by black slaty or cherty members, in which there is iron pyrites, the oxidation of which has greatly discolored the formation. One of these occurrences is just east of mileage 162. The most important iron formation in the area is to the north of the Dane-Larder lake road in the township of Boston. This iron range, which consists of interbanded silica and magnetite, has been little developed, but a number of pits have been sunk upon it. It has been described by W. G. Miller and W. A. Parks. The bands have been traced over several miles, in the north part of the township, by means of isolated exposures. At one time the formation covered a large area, but was infolded with the underlying greenstone and then eroded. The exposures now consist of narrow, approximately vertical bands. This iron formation was staked several years ago. It was later restaked as gold prospects. The iron bands have been broken up, and quartz veins have been formed, and in some of these gold has been found. At other places, as on H. R. 1401 (Dane Copper Mining Company), the iron formation has been impregnated sufficiently with copper pyrites to be worked as a copper prospect and some tons of copper ore have been shipped.

TIMISKAMING SERIES

A series of sedimentary rocks was laid down on the eroded surface of the Keewatin complex. These rocks have been infolded with the Keewatin and eroded so that the series has now a highly inclined attitude. The strike of the inclined strata is in a general east and west direction while a schistosity has been developed in a northeast and southwest direction. The greatest development of this series is in the townships of Teck and Lebel, and probably represents a syncline. Owing to the amount of drift and the many intrusions of dikes into the series, it is difficult to determine whether the structure is a syncline or not. The lower formations have been largely altered to schist, but conglomerate, slate and greywacké, with some cherty iron formation can be recognized at places along the north and south boundaries of the series. The rocks toward the central part are more readily recognizable, being represented chiefly by boulder conglomerate with bands of greywacké and quartzite. The series can be traced easterly, with less conglomerate and more of the fine-grained schistose types outcropping, to the Larder lake area. In the Kirkland lake area, several unconformities

Conglomerate of the Timiskaming series which has been rendered highly schistose. North of O'Connell lake, Lebel township.

were found. The Timiskaming series was laid down on an eroded surface of the Keewatin, the overlying conglomerate containing fragments of the greenstone (basalt), old diabase, and altered quartz feldspar-porphyry of the Keewatin. These unconformities can be seen on mining locations: L. 2796 in the northwest part of Lebel township; L. 1824 (H. S. 1199) on the south shore of the northwest bay of Kirkland lake; and on the north shore of Gami lake. The greatest width of the series of nearly three miles is along the boundary line between Teck and Lebel.

Like the Keewatin, the Timiskaming series has been impregnated with carbonate solutions. A rock which has been altered to ferruginous carbonate outcrops about nine chains north of O'Connell lake. Some of the conglomerate bands have been compressed into schist as shown to the northeast of O'Connell lake. At other places where the pebbles are of hard porphyry, chert and other material the matrix has been rendered schistose and the pebbles are readily separated from the matrix. A conglomerate of this character occurs to the north of Gull lake on L. 2452. Isolated patches of the Timiskaming series which have escaped erosion outcrop at points along the Dane-Larder lake road.

The series is well exposed along the railway track west from Swastika to Kenogami. South of Kenogami station the beds of conglomerate and greywacké are almost vertical, while just west of the station rocks of the Cobalt series are in almost undisturbed position.

Sections of Greywacke

A microscopical examination was made of greywacké from the vicinity of the Tough-Oakes mine, just south of No. 3 vein, near the Teck-Lebel line. The greywacké is composed of angular fragments of quartz, orthoclase, plagioclase, chlorite, and other minerals, with considerable carbonate scattered through it. The rock is quite readily recognized as of sedimentary origin. A rock from the original shaft of the Burnside is similar to this. The impregnation of the rocks by much carbonate or sericite aids in distinguishing them from greywackés of the Cobalt series.

Variety of Pebbles in the Conglomerate

There is a great variety of pebbles in the conglomerate, including various greenstones, diabase, porphyries, felsite, an occasional granite and numerous fragments of iron formation. Some of the fragments of iron formation are of a bright, red jasper, which gives the rock a very striking appearance. There are also pebbles of quartz with pyrite from an older series of veins than the Kirkland lake gold-bearing veins.

The sedimentary rocks shown in Gauthier township extend into McVittie township. The slate and associated rocks are mapped by Mr. M. E. Wilson with the Keewatin, and the conglomerate with the Huronian. The conglomerate that outcrops at Larder Lake village, and which is intruded by lamprophyre, is similar to that at Kirkland lake, and for purposes of correlation may be called "Timiskaming." The similarity of the conglomerate at Larder lake to the Timiskaming series at Cobalt has been referred to by Mr. M. E. Wilson.[1]

It is possible that there may be an unconformity in the series which is mapped as Timiskaming, i.e., the lower portion, consisting largely of slate, glossy schist, and carbonate rock, may have been eroded before the deposition of the upper, largely conglomerate portion of the series. There is a concordance in the strike of the sediments, and no unconformities were observed; hence all these sediments were mapped as one series.

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[1] Memoir No. 17-E, Geological Survey, Canada, p. 38.

Timiskaming series, exposed on the Dane-Larder lake road.

Conglomerate of the Timiskaming series. Half mile north of Gull lake, Lebel township.

POST-TIMISKAMING INTRUSIVES

Lamprophyre

Dikes of lamprophyre are common in the Keewatin and Timiskaming. In the Keewatin the dikes are usually quite narrow, some of them being only ten or fifteen feet wide. The cuttings along the railroad from Swastika to Boston creek reveal many lamprophyre dikes. Just east of Amikougami creek there is a mica-lamprophyre, quite black in color. Immediately south of Boston creek bridge there is a reddish lamprophyre (minette), which shows glistening biotite in hand specimens. Under the microscope biotite and hornblende are seen to be abundant. Chlorite, with needles of rutile, an alteration from the mica, is common. There are a few porphyritic feldspars, and microcline is abundant. Quartz in small grains is present. Sphene, apatite and magnetite are accessory minerals. Lamprophyre intrudes the Timiskaming series in some volume, as shown on the accompanying map. In the large area in northwest Lebel there is a reddish rock which appears to be a differentiation from the normal black lamprophyre. Often there is a ribbed structure in the rock, due to very narrow dikes, an inch or so in width, which intersect the lamprophyre. These dikes may fill cooling cracks since they were not observed extending into any of the adjacent rocks. A pitted surface, due to the leaching of the ferro-magnesian mineral, is another marked character of the lamprophyre. A schistose structure is also often developed. This rock is the oldest of the intrusives into the Timiskaming series.

Mr. E. L. Bruce has described an augite-lamprophyre from the north shore of the Blanche river in Eby township. Numerous phenocrysts of augite are set in a groundmass made up of needle-like feldspar and smaller augite crystals.

There is a somewhat similar lamprophyre on mining claim L. 2445 in northwest Lebel. The phenocrysts of augite are altering to hornblende. Lamprophyre is well exposed just south of the mill at the Tough-Oakes mine.

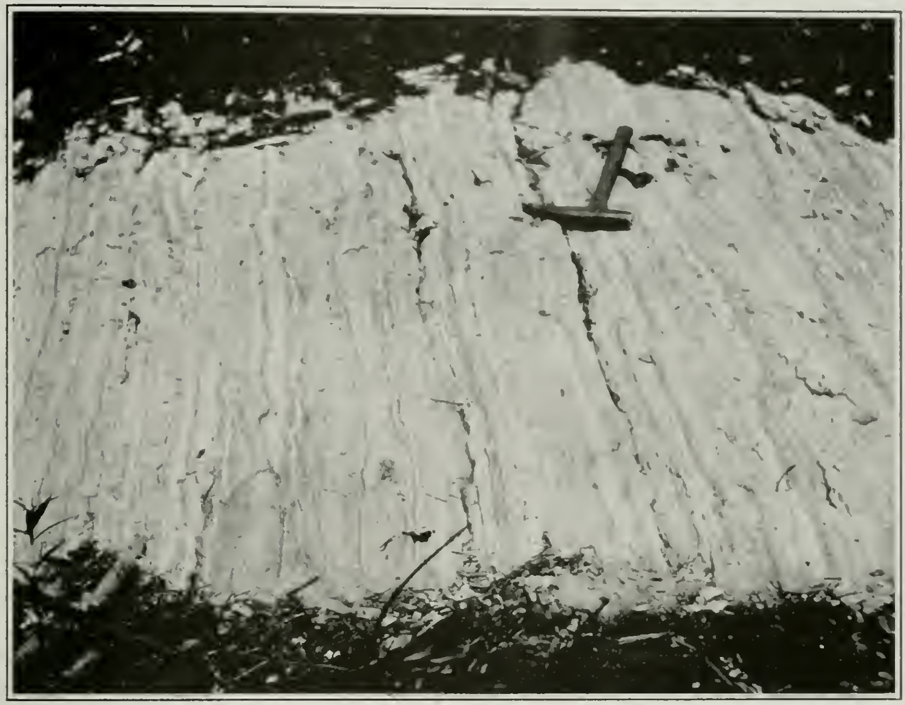
Analyses of Lamprophyre

	1. Per cent.	2. Per cent.
Silica	48.50	52.29
Alumina	22.43	19.38
Ferric oxide	2.85	4.40
Ferrous oxide	4.78	6.00
Lime	7.62	7.79
Magnesia	1.16	3.54
Potash	3.56	4.12
Soda	3.38	2.12
Carbon dioxide	3.72	....
Water	2.26	.95

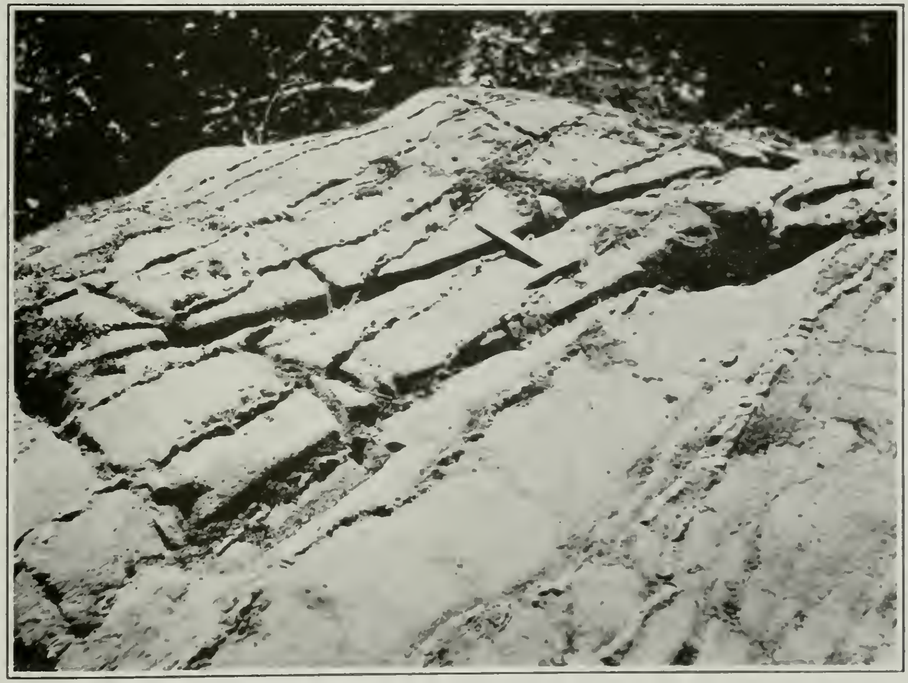
1. Lamprophyre from Wishman claim, N.E. of Kirkland lake.
2. Lamprophyre, north of main Blanche river, Eby township. Analyst, E. L. Bruce.

Syenite

Two large batholiths of syenite are shown on the map. Of these the syenite in Otto township has a predominant reddish color, while that in Boston and Lebel is generally greyish. The rocks of both areas are usually quite massive in structure, except along the margins of the older rocks, where a gneissoid structure is sometimes developed. Tongues of syenite intrude the greenstone.



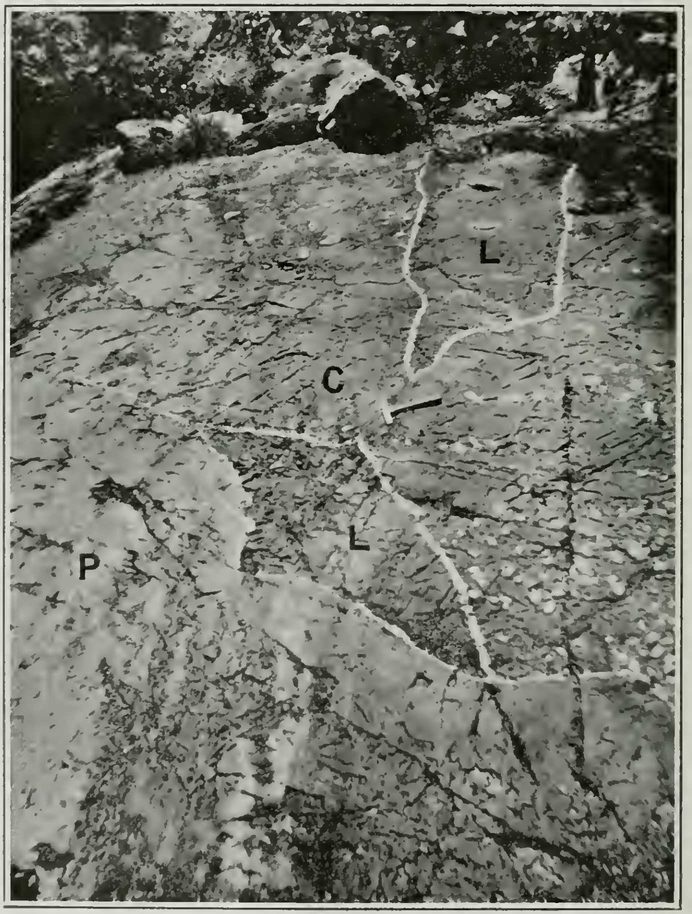
Iron formation of the Timiskaming series, north of Mud lake, Lebel township.



Lamprophyre dike on Wishman claim to the N.W. of the Tough-Oakes mine.

An examination of a syenite from concessions IV and V, Otto township, by Mr. E. L. Bruce showed that the prominent feldspar is a plagioclase near the albite end of the series. Other constituents are orthoclase, quartz, biotite, hornblende and pyroxene. An analysis of the syenite by Mr. Bruce gave the following results: Silica, 61.65; alumina, 18.91; ferric oxide, 2.37; ferrous oxide, 1.48; magnesia, 1.11; lime, 2.10; potash, 4.20; soda, 5.59; water, 0.60.

A quartz-hornblende syenite, from the south boundary of Otto near the half-mile post betweens lots 9 and 10, consists largely of albite, microcline and microperthite, with smaller amounts of hornblende, chlorite, quartz, apatite, and intergrowths of quartz and feldspar.



Conglomerate (C) of the Timiskaming series which has been intruded by lamprophyre (L). At a later period both rocks have been intruded by feldspar-porphyry (P). Claim L. 2491, Teck township.

Granite

Around Winnie's lake, in the northwest part of the area, there is a mass of coarse, reddish, hornblende granite. This rock evidently changes to a syenite when followed to the northwest into Maisonville township. Under the microscope the granite from east of this lake shows numerous large crystals of albite (with zonal structure), and some quartz and hornblende set in a matrix of quartz, orthoclase and albite with smaller amounts of chlorite, apatite and magnetite.

Feldspar-Porphyry

An intrusive rock, of an acid or intermediate composition, very prominent in the Kirkland lake area, is a reddish or greyish porphyritic rock containing phenocrysts of feldspar (albite). The predominating color of the porphyry is red, often of a deep rich color. In parts of the area this rock is in quite large volume, as around the east end of the southeast bay of Kirkland lake, extending northeasterly to the Tough-Oakes mine and being about a claim in width. Then, again, the porphyry may occur as narrow dikes only a few feet wide and too small to map. Such dikes can be observed along the south shore of Kirkland lake. The fractures in the older rocks strike in a general northeast and southwest direction and conform to the general schistosity of the country. The dikes and masses of porphyry for a great part also extend in this direction. The intrusions of feldspar-porphyry are not so abundant in the Keewatin as in the Timiskaming, probably because the conglomerate and greywacké were more readily fractured than the tough Keewatin greenstone. The porphyry varies considerably in texture, from a coarse rock with readily recognizable phenocrysts to a fine-grained, felsitic rock requiring a microscopic examination to reveal the feldspar phenocrysts. In the coarser phases the phenocrysts average 1-16 to 1-8 inch. They vary in color from a deep red to almost white. Occasionally eyes of clear quartz occur in the porphyry. Scattered blades of biotite, some of which are altered to chlorite, are often recognized in hand specimens. Microscopically the feldspar phenocrysts often exhibit a beautiful zonal structure. Zones of sericitic material are frequently recognized in the phenocrysts, probably the result of alteration of some intergrown orthoclase. There are a few scattered crystals of quartz, generally smaller than the feldspar phenocrysts, and laths of biotite, some of which show alteration to chlorite. The groundmass is fine-grained, consisting largely of feldspar with some quartz.

Analyses of feldspar-porphyry gave the following results:—

	1. Per cent.	2. Per cent.	3. Per cent.
Silica	66.30	66.48	56.25
Alumina	15.37	15.42	18.42
Ferric oxide	0.37	1.05	1.56
Ferrous oxide	1.47	1.18	7.41
Lime	3.06	3.15	6.13
Magnesia	1.16	1.67	2.38
Potash	3.86	2.56	0.32
Soda	4.78	5.97	8.10
Carbon dioxide	3.34	2.65	4.58
Water	0.60	0.30	0.22

1. Tough-Oakes, near No. 1 vein.
2. Teck-Hughes, near vein east of No. 1 shaft.
3. Cut west of Swastika station.

Nos. 1 and 2 analyses are very similar, while No. 3 is quite high in soda, indicating a rock composed chiefly of albite, which may be called an albite porphyry. The analysis of No. 3 was made by Mr. E. L. Bruce, whose comments are given in his report on "The Swastika Gold Area."[1]

The name "feldspar-porphyry" has been used for this reddish or greyish porphyritic rock rather than the name "porphyrite" or "diorite porphyrite." Phenocrysts of albite are prominent in the rock, while other acidic feldspars are also present. The ferro-magnesian minerals occur only in minor quantity. In some phases of the rock the abundance of albite suggests the term "albite porphyry." MacLaren[2] uses the term "albite porphyry" or "feldspar porphyry" to describe a dike rock which is associated with the gold deposits of Kalgoorlie, West Australia. The albite porphyry of Kalgoorlie is characterized by the presence of notably large, well-shaped crystals of feldspar, but does not contain the hornblende or biotite that are found in the porphyrites which are described by MacLaren as ranging from dark grey to bluish rocks like diorite to light porphyritic rocks distinguishable with difficulty from feldspar-porphyry.

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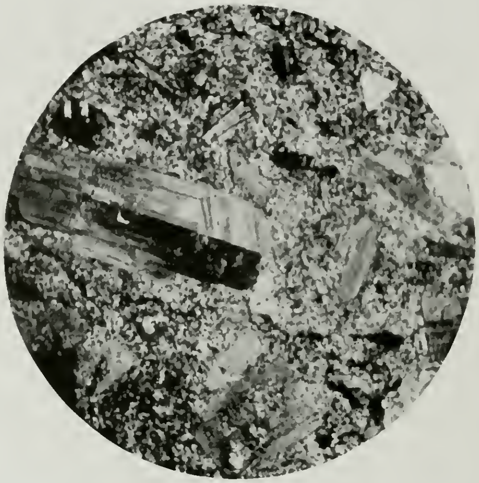
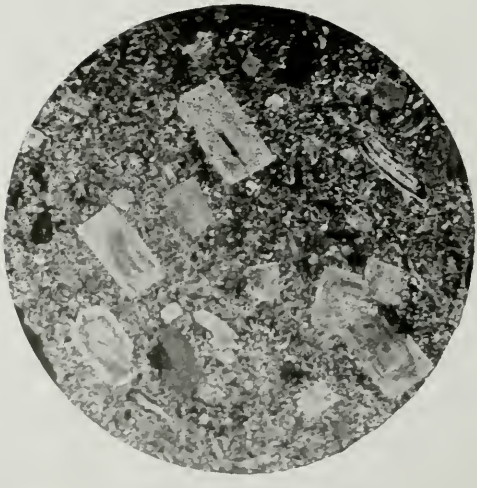
[1] 21st Annual Report, Bureau of Mines, Ont., 1912, p. 262.

[2] Geology of the Kalgoorlie Goldfield, Mining and Scientific Press, 1913, Vol. 107, p. 97.



Photomicrograph of reddish feldspar-porphyry, from north part of Burnside claim, L. 1823. X 19 diameters.



Photomicrograph of greenish feldspar-porphyry from wall of gold bearing vein on Burnside claim, L. 1823. The rock contains considerable sericite. X 19 diameters.

COBALT SERIES

There is only one small area of conglomerate, that in the southeast part of Grenfell township. This conglomerate extends westerly to Kenogami lake, where it is well exposed. Just northwest of Kenogami station there is a prominent hill about 110 feet in height, where conglomerate unconformably overlies Keewatin ellipsoidal greenstone. The conglomerate contains numerous boulders of syenite and granite and is very little disturbed, whereas only a few hundred feet to the south the Timiskaming series has been greatly folded, the strata being in almost vertical attitude. The two series were not observed in contact.

Scene on Kirkland lake.

DIABASE

There are a few dikes of fresh diabase which is the most recent rock in the area. A dike of red feldspar-porphyry has been intruded by a dike of diabase on the Hunton claim south of Kirkland lake.

View of Blanche river, Otto lake and Swastika mine from T. & N. O. Railway.

Origin and Age of Gold Deposits

All the gold deposits of northern Ontario are in the pre-Cambrian, in rocks which, with few exceptions, are older than the Cobalt series. After the folding of the Timiskaming series and before the deposition of the Cobalt series, there was a period of igneous activity during which basic and acid rocks, including lamprophyre, porphyry, syenite and granite, were intruded into the older rocks. The lamprophyre is distinctly older than the other intrusives and has no bearing on the ore deposition. The probable genetic relationship of the gold deposits of Porcupine to granite intrusions has been noted in a report on that area. There are a number of gold-bearing veins at Kirkland lake, along the contact of intrusive feldspar-porphyry and older rocks, suggestive of a relationship between the intrusive and the veins. There are areas of granite and syenite within a short distance of the gold deposits. An examination of a number of specimens from these plutonic areas shows that these rocks contain albite, usually as phenocrysts, similar to the feldspar-porphyry. It is quite likely that the granite, syenite and feldspar-porphyry belong to the same period of intrusion and are different facies of a plutonic rock which underlies the whole area. The syenite and granite have been exposed by deep erosion.

While the gold-bearing veins were formed subsequent to the intrusion of the porphyry, it is likely that they are genetically connected with the intrusive rock which occurs as dikes and boss-like masses. The cooling of the intrusive was apparently accompanied by shrinkage, faulting and displacement in the porphyry itself and in the adjacent rocks. The gold-bearing, silicious solutions that deposited their burdens in the fissures and other fractures in all probability represented the end product of the intrusion of the acid rocks that have been mentioned.

Lindgren[1] in his classification of mineral deposits places the gold-quartz veins of Ontario in the division of "veins and replacement deposits formed at high temperature and pressure and in genetic connection with intrusive rocks." He says: "These veins are clearly related to those of the southern Applachian states, but, on the other hand, they present some remarkable analogies with those of California." The veins of Kirkland lake, which are somewhat unlike those in other parts of the Province, had not been discovered prior to the publication of Lindgren's description. These veins were formed at considerable depth and have been exposed by extensive erosion, but it is probable that they were not formed at as high temperatures as the veins at Porcupine, in which tourmaline and pyrrhotite frequently occur. The minerals tourmaline, pyroxene, garnet, amphibole and biotite, characteristic of deposits formed at high temperatures, have not been recognized by the writers in the Kirkland Lake area. Albite, chlorite, sericite and carbonates are present in the deposits as alteration products. The veins at Kirkland lake in their mineral constituents greatly resemble those of the Sierra Nevada, California, which are described by Lindgren.[2] In these latter veins tellurides like altaite, hessite, calaverite, petzite and melonite are frequently associated with native gold.

In a comparison of the Cripple Creek and Kalgoorlie gold deposits, Lindgren has shown that telluride of gold may be deposited in large quantities both near the surface (as at Cripple Creek), and at a depth of many thousands of feet below it (as at Kalgoorlie).[3] Telluride of gold is not so abundant in the Kirkland lake deposits as telluride of lead, but probably occurs in greater quantity than has been suspected owing to the difficulty of identifying the telluride in fine grains when accompanied by native gold. As stated above, the mineral associations at Kirkland lake are not typically those of high temperature deposits. Magnetite has been found in gold-bearing veins at the Huronian mine, a few miles east of Kirkland lake, and specularite has been reported in veins from the Tough-Oakes mine. The Kirkland lake deposits have probably been formed at considerable depth, like the Kalgoorlie deposits, but not at such high temperatures, while the mineral association is somewhat similar in that native gold accompanies the tellurides.

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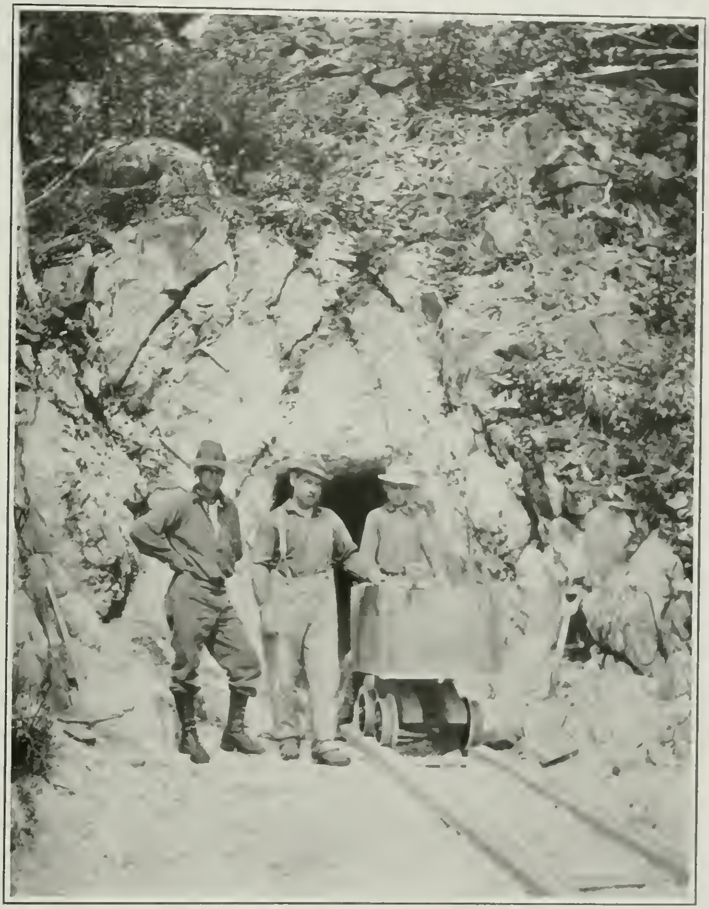
[1] Mineral Deposits, W. Lindgren, p. 635. [2] Ibid, p. 530.

[3] Economic Geology, 1905-6, Vol. I, 542, "Metasomatic Processes in the Gold Deposits of Western Australia."

The physical characters of the veins at Swastika and Kirkland lake are somewhat different. At Swastika the veins are generally several feet in width and are composed chiefly of white quartz with a few fracture planes, whereas at Kirkland lake the veins are quite narrow, often extremely brecciated and impregnated with secondary material, the quartz sometimes forming only a small portion of the ore body.



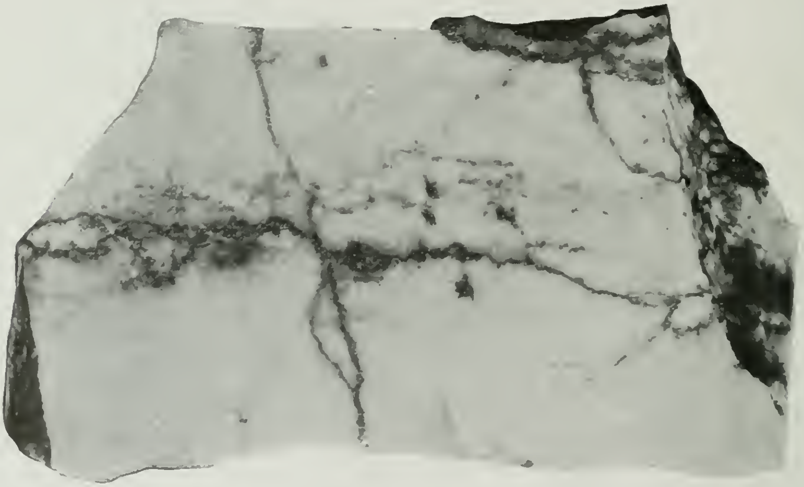
Prospecting on the Blanche river in the south part of McElroy township

The productive veins at Swastika are in the altered Keewatin greenstone, while no veins of economic importance have been found in the conglomerate, although the rock is intruded by the feldspar-porphyry. There is no apparent reason why the conglomerate at Swastika should not carry gold-bearing veins as at Kirkland lake. The same may be said of the feldspar-porphyry at Swastika which has not been proved to contain economic gold-bearing veins, though this rock at Kirkland lake shows some promising veins. The veins at Swastika in their general character, width of quartz, lenticular form, and other features, resemble the veins in the Porcupine area.

Tellurides have not been reported in the veins at Swastika, but molybdenite, of such frequent occurrence in the Kirkland lake area, has been found in several veins at the Lucky Cross mine.

The Swastika Area

The first development work in the areas described in this report was done near Swastika village, where mining operations were carried on at the Swastika and Lucky Cross properties. These mines are equipped with power plants and small stamp mills, and some bullion has been produced, but at the present time both properties are closed down. The ore deposits consist of quartz veins, sometimes five to seven feet wide. Development has shown that the values occur in shoots in the veins. There are often streaks of dark-colored mineral, roughly parallel with the walls of the vein, along which gold is more abundant than in the white quartz. A polished surface of ore from No. 1 vein of the Swastika mine shows white quartz with dark streaks along which the quartz has been greatly fractured. Along these lines of weakness there has been a concentration of gold and iron pyrites, in places showing rather continuously. In the crushed portions of the quartz there are small clusters of particles of iron pyrites and gold. High values frequently occur along the junction of the quartz with the schist. Minute veinlets of clear quartz up to ⅛-inch in width cut the vein quartz and are later than the gold. Calcite and other carbonates are sometimes present in the veins. The best veins occur in the greenstone near the contact with feldspar-porphyry, while the veins in the light-colored intrusive rock have not been found promising in the Swastika area.



Gold-bearing quartz showing the brecciation of the primary quartz and the deposition of pyrite and gold along fracture lines, Swastika mine.

Kirkland Lake Area

Prospecting has shown a promising area, extending in a general N.E. and S.W. direction, from about half a mile southwest of the southwest bay of Kirkland lake to the vicinity of the Teck-Lebel boundary line. In this area a number of gold-bearing veins have been discovered in the conglomerate and porphyry, there being no outcrops of Keewatin rocks. Further prospecting may show that this gold-bearing area extends beyond the boundaries mentioned above, since the same character of rocks and igneous intrusions occur for some miles on the strike of the Timiskaming series. The schistose older rocks, like the conglomerate and greywacké, have a general N.E. and S.W. strike, which is also the direction followed by the porphyry dikes and other intrusions. The strike of the majority of the veins is also in the same direction.

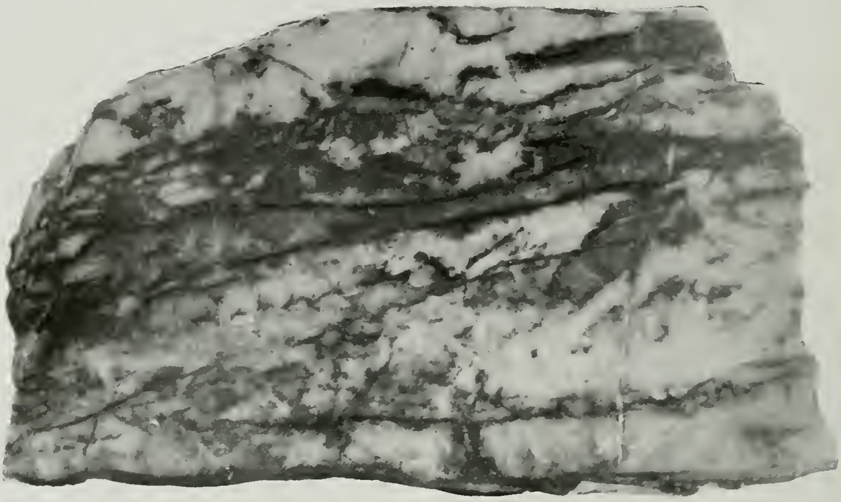
Gold-bearing veins have been found to the north of this area in Keewatin rocks, namely, in the southwest part of Morrissette township and near the boundary line between Teck and Lebel in the vicinity of Gami lake.

Veins occur not only in the rocks adjacent to the porphyry but also in the porphyry itself, and several veins have been found which pass from the conglomerate into the porphyry. The schistose conglomerate is more likely to contain a well defined, though narrow vein, than the porphyry. In the latter rock there is often a series of quartz stringers and narrow quartz lenses formed along the strike of a fractured zone, producing an ore deposit of a stockwork or stringer lode type, in which numerous quartz veinlets intersect the porphyry. A main fissuring in the conglomerate may also be accompanied by subordinate fissuring, producing somewhat similar deposits. The veins in the conglomerate are generally parallel to the schistose structure, but sometimes they cross the schist for short distances, producing an irregular strike, as can be seen in No. 3 vein of the Tough-Oakes, where it occurs in the conglomerate and greywacké. The dip of the vein may also follow that of the inclined sediments. In part of No. 2 vein of the Tough-Oakes mine, on the east drift at the 100-foot level, the hanging wall is conglomerate and the foot wall is greywacké. A roughly banded structure is sometimes shown in the veins, due to shear planes being developed in the earlier vein filling.

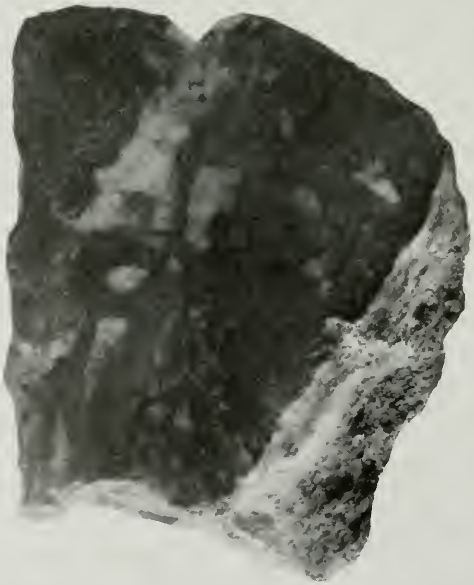
The high-grade ore occurs in the narrow veins, while there may be a lower-grade ore in the wall rock along the veins, so that several feet of ore can sometimes be mined. Development has not proceeded sufficiently far to determine the nature of the ore shoots in the veins as to their length, pitch, relation to contact, and other characteristics.

Minerals in Kirkland Lake Veins

The oldest mineral in the veins is a coarsely crystalline quartz. Usually this quartz has been broken up and other minerals deposited in the fracture planes. Of these there is quartz, often of a somewhat darker color than that first deposited. Carbonates of various composition are present in the veins. A pink carbonate, on analysis, proved to be calcite with 5.34 per cent. of magnesium carbonate; a grey variety is ankerite. There have been different periods of fracturing. Some of the quartz is later than the carbonates. Where there have been inclusions of country rock in the vein and replacement, some sericite has been developed. Chlorite also occurs as a vein material. Iron pyrites is the most abundant of the sulphides, being found both in the wall rock and in the veins, usually in well crystallized forms. Some of the pyrites in the vein is in fine grains. Copper pyrites occurs to some extent, generally where the vein is gold-bearing. Galena and zinc blende occur in very small quantity. The latter material has been observed in small encrustation veinlets, which are later than the ore. Molybdenite has been deposited abundantly in fractures, usually as a thin film. Gold-bearing solutions have circulated along these planes, and the veins have been enriched by the deposition of gold in these later fractures. Later movements have often slickensided these planes, while the gold, altaite and other minerals may be polished. In some cases the gold has been deposited after the slickensides have been formed, since veinlets of the metal have been observed on the 200-foot level of the Tough-Oakes mine, cutting across the smooth planes of the molybdenite.



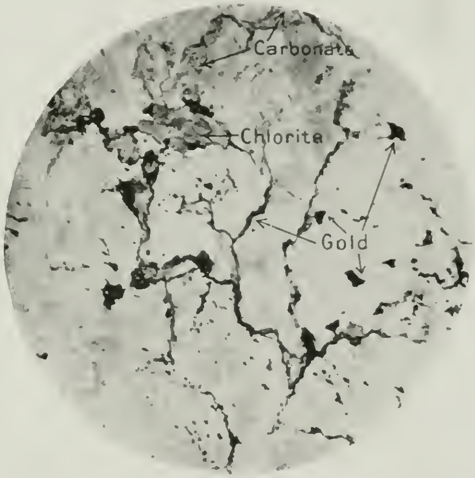
Gold-bearing ore from vein No. 2 in the conglomerate, Tough-Oakes mine. Specimen shows the repeated fracturing to which the vein has been subjected.



Gold-bearing ore from vein No. 2 in the conglomerate, Tough-Oakes mine. The original quartz filling of the vein has been greatly brecciated.

Tellurides and Gold

There are several tellurides in the ore. Of these altaite, telluride of lead, has been observed in a number of veins somewhat abundantly. It is best recognized by its well developed cubical cleavage and brilliant cleavage faces. It is often accompanied by visible gold. Tests made by Mr. W. K. McNeill, Provincial Assayer, have shown that both molybdenite and altaite will precipitate gold from chloride solution. Messrs. Campbell and Deyell, of Cobalt, have reported the presence of tetradymite (telluride of bismuth) and hessite (telluride of silver) in ore from No. 2 vein of the Tough-Oakes mine. Several tests have been made at the provincial assay office for gold telluride in ore from the Tough-Oakes mine, but the suspected mineral usually proved to be the telluride of lead. However, one telluride which came from the shaft on No. 3 vein has proved to be a gold telluride. The material was very carefully examined for visible gold, and only the massive brittle mineral of a very pale bronze, almost white, color was examined. On assay, it yielded 40.6 per cent. gold. Other specimens yielded a yellow globule of gold before the blowpipe. Theoretically, telluride of gold ($AuTe_2$) contains 43.7 per cent. gold. Calaverite corresponds closely to the formula for gold telluride, but usually contains low percentages of silver. The mineral which is described above is probably calaverite, but it contains no silver.



Thin section of gold bearing quartz from vein on Wright-Hargrave. Carbonate, molybdenite, chlorite, telluride (altaite?), gold and other minerals occur in th fracture planes of the quartz. X 10 diameters.

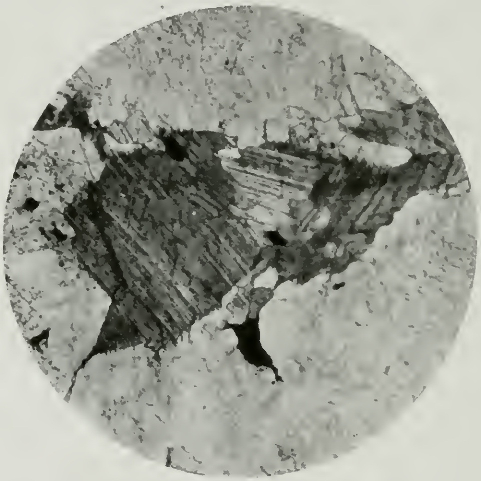
The gold occurs for the most part in the native form, much of which is visible to the eye. A mass of coarse gold taken from the mortar box of the stamp mill at the Tough-Oakes mine contains 904.7 parts fine gold and 73.1 parts fine silver.

There are probably some silver-bearing minerals other than hessite which have not been recognized, since the assays of shipments of high-grade ore show a higher proportion of silver than gold, which is not accounted for in the recovery of silver by amalgamation in the stamp mill of the Tough-Oakes mine.

There have been different movements in the veins, resulting in repeated circulation of gold-bearing solutions with deposition of the gold in the fractures. Native gold has been observed in various constituents of the vein, namely, in the glassy white quartz; in the cleavage planes of calcite; in a group of minerals like quartz, albite and carbonates. The gold is usually associated with some of the sulphides, like pyrite, molybdenite and copper pyrites, and tellurides like altaite.

Microscopic Examination of Ore

An examination of a number of thin sections of ore from the Kirkland Lake area shows that the vein material has been much brecciated. Fragments of coarsely crystalline white quartz are often surrounded by secondary minerals. Gold has been observed in contact with altaite, molybdenite and iron pyrites. In one case an isolated grain of gold incased a grain of telluride. Fragments of greywacké or porphyry are surrounded by vein minerals. One section shows the quartz greatly fractured and an interlacing meshwork of metallic minerals occurs in the fractures. The crystallized calcite frequently contains gold which has followed along the rhombic cleavage planes. Small clusters of dark minerals, sulphides, tellurides and gold, occur throughout the crushed vein material, while similar minerals sometimes concentrate along the margins of included fragments like bits of greywacké or conglomerate. Carbonate veinlets frequently cut through the quartz and included fragments of rock.



Thin section of gold-bearing quartz from No. 2 vein, Tough-Oakes mine. Quartz has been replaced by carbonate. Black spots are native gold. X 19 diameters.

Development

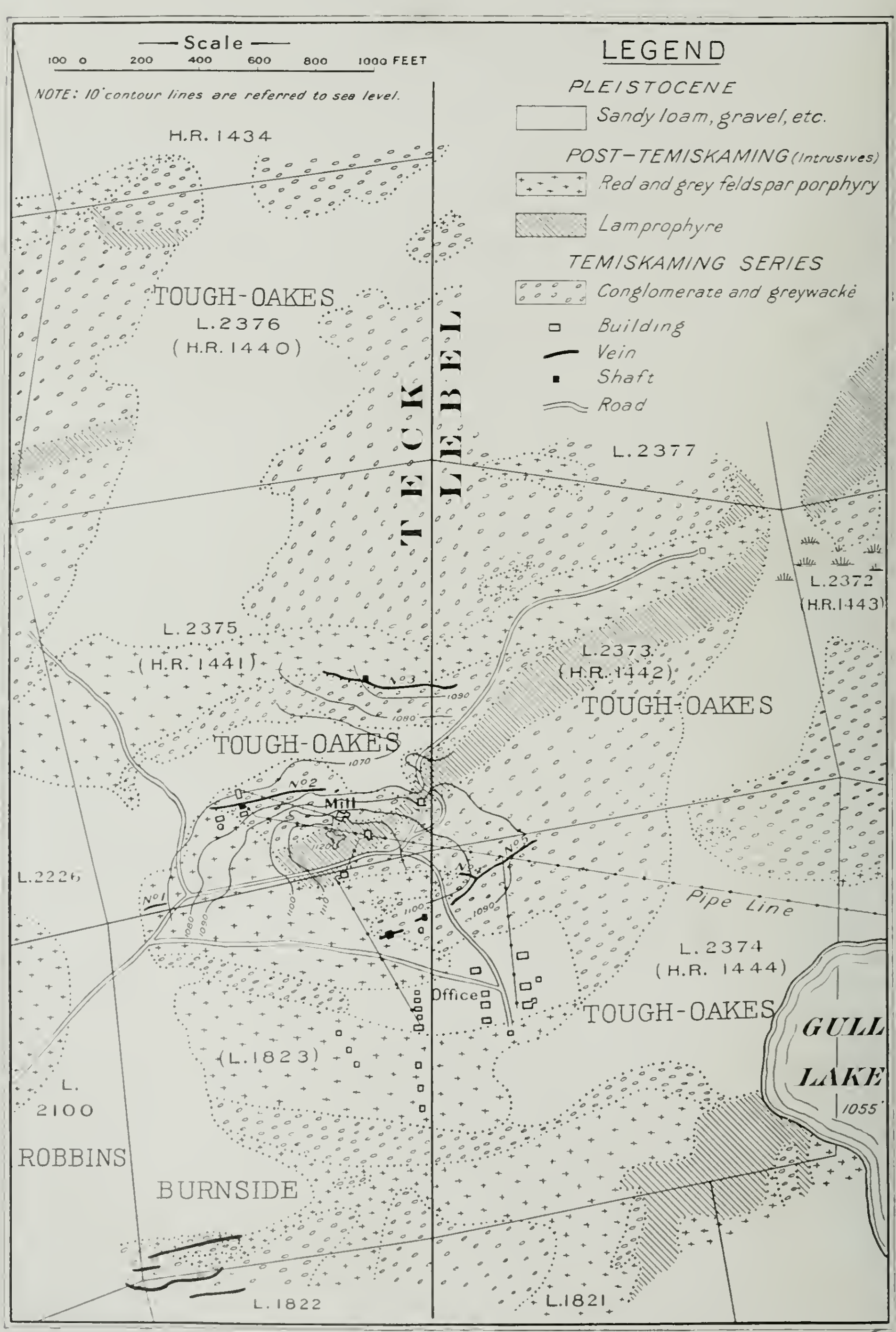
Tough-Oakes Mines

This property consists of a group of five claims (Nos. H. R. 1440 to 1444), situated along the boundary line between Teck and Lebel townships. Surface prospecting resulted in the discovery of five veins, of which Nos. 2 and 3 were most promising. The greatest development has been on No. 2 vein, which has been traced for 390 feet by means of trenching. The vein is narrow, but showed some extremely high-grade ore on the surface. An open cut was first made on a part of the ore shoot, and from this development two shipments of high-grade ore, which was hand-sorted, were made. The open cut measured 65 feet in length, 7 feet in width and 20 feet in depth. An inclined shaft was then sunk on the vein, which from the surface to the 200-foot level has a dip of about 60° S. At the 100- and 200-foot levels drifts were run to the east and west, following the somewhat irregular strike of the vein. An ore pocket was also constructed at the 100-foot level. The main No. 2 vein, while narrow, is generally very well defined, showing in places a rough banding due to movement. The vein is often greatly brecciated with angular fragments of quartz or country rock in a later cementing material. In the easterly drifts at the two levels the vein is in the conglomerate and greywacké of the Timiskaming series, while in the westerly drifts it crosses the contact into the porphyry a short distance from the shaft. The porphyry has also been encountered in sinking the shaft from the 200- to the 300-foot level, with the vein extending into the porphyry. Development on the vein where it occurs in the porphyry has shown that the high-grade character of the vein filling has extended beyond the contact with the conglomerate. The contact of the conglomerate and porphyry, as revealed in the workings, shows that the porphyry overlies the sedimentary rock at a high angle. Where an open fissure has not been formed, the rock along the fissure plane has been greatly crushed and numerous slip planes have been formed along which gold-bearing solutions have circulated. In these planes quartz, molybdenite, gold and other minerals have been deposited. The formation of the vein fissures was accompanied by faulting, and fragments of wall rock occur in the veins. There are, in addition to the main vein, somewhat parallel stringers of quartz for some feet from the vein, affording workable ore with the included wall rock which is greatly impregnated with secondary material. Some of the vein material from the porphyry on the 200-foot level contains flesh-colored albite in coarsely crystallized masses, giving a pegmatitic structure to some of the vein. Calcite and ankerite occur with the quartz and albite, and grains of gold are disseminated through these minerals. A series of minor thrust faults have displaced No. 2 vein of the Tough--Oakes mine on the 200-foot level. The greatest throw observed is a foot.

A shaft has also been started on No. 3 vein, which is 400 feet north of No. 2. The easterly part of this vein is in the greywacké-conglomerate, and the westerly part in the red feldspar-porphyry, while the dip is to the south, similar to that of No. 2 vein. The shaft was started in the porphyry, while between the two veins, Nos. 2 and 3, is a band of conglomerate which is mostly concealed by drift. The workings from this shaft will be connected by a cross-cut with the 200-foot level workings on No. 2 vein. The cross-cut will prospect ground in the conglomerate that is adjacent to the contact of the intrusive porphyry which lies to the west. No. 3 vein, as exposed on the surface, is in close proximity, over its whole length, to the contact of the conglomerate and porphyry.

Greywacké was encountered in the hanging wall at 70 feet in the shaft on No. 3 vein, while about one-third of the shaft at 90 feet is in the greywacké, the narrow high-grade vein still being in the porphyry. The structure in this shaft is the reverse of that in the shaft on No. 2 vein, where the vein at the surface is in conglomerate, while porphyry came in on the hanging-wall side at depth.

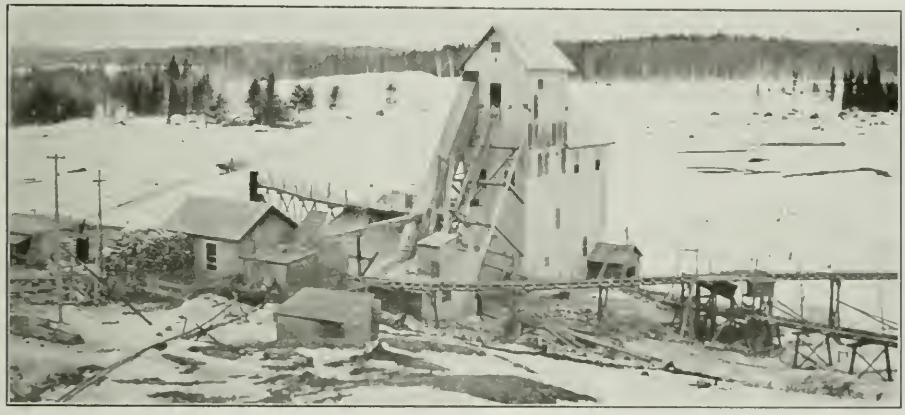
With the exception of the ore from the open cut, the excavation for the ore pockets at the two levels, and the sump on the 200-foot level, the ore raised from the mine has come from development of shaft and drifts.



Plan of the Tough-Oakes and Burnside mines. Mine plans furnished by M. W. Hotchkin.

The material, as it comes from the mine, is hand-sorted on a bumping-table, and the high-grade ore is bagged for shipment to the smelter. The balance is placed on the dump, from which a part is transported to the mill, where it is treated by crushing in a battery of five 1,050-lb. stamps, and passed over amalgamating plates which catch about 50 per cent. of the head values. The tailing is impounded for future treatment. This treatment is only temporary, pending experiments on the ore, which will suggest the type of mill to be erected.

The power for the mine and mill will be furnished by electric motors driven by power transmitted from a hydro-electric development at Charlton, a distance of twenty-five miles.



Surface plant at No. 2 vein, Tough-Oakes mine.

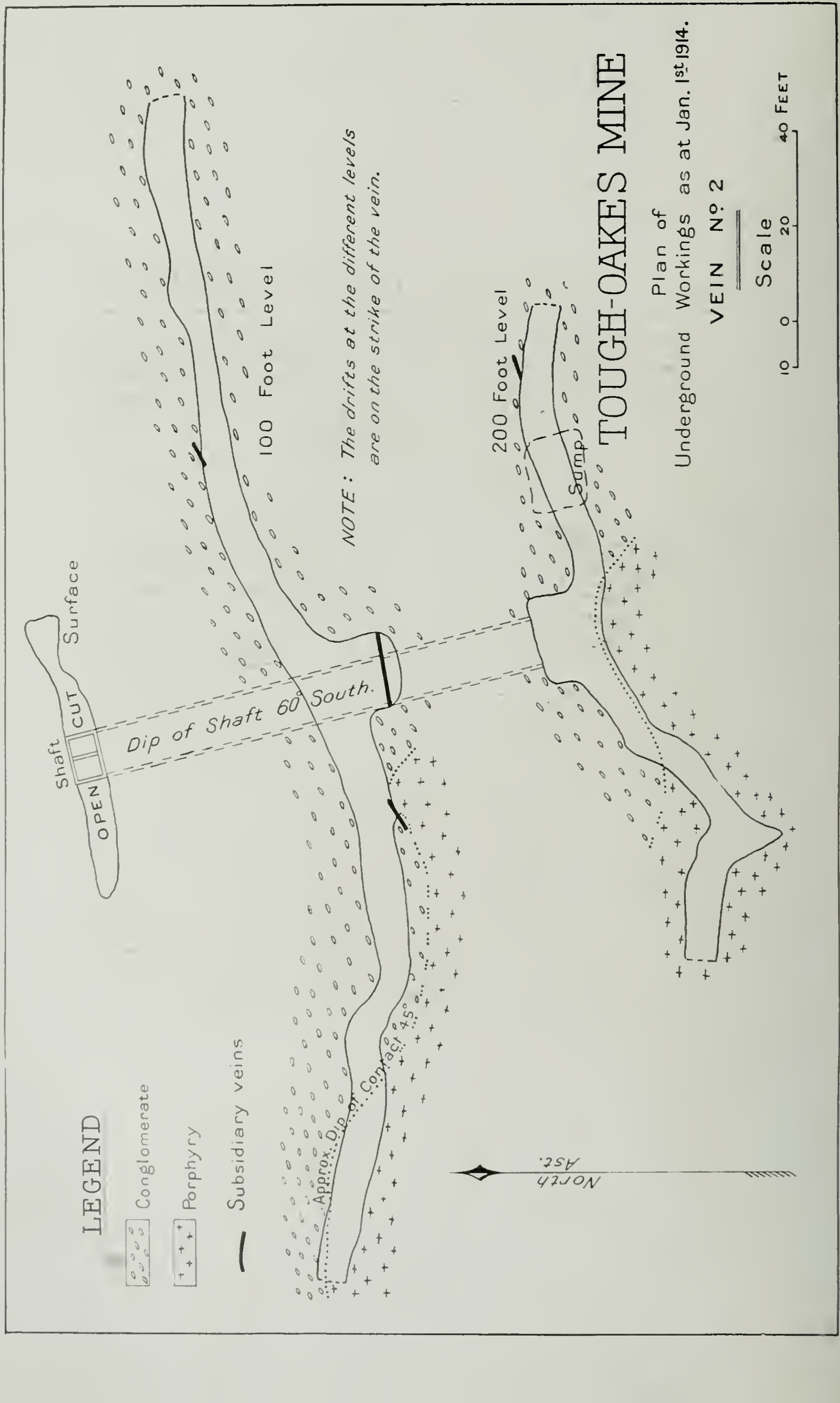
Photo. R. F. Hore.

Up to January 1st, 1914, the following shipments of high-grade ore were made from the Tough-Oakes mine:

Ore shipments	Date	Tons	Silver	Gold	Gross Values
			Oz. per ton	Oz. per ton	
Lot A	Sept. 18, 1912.....	1.89	....	17.45	660.37
Lot B	Dec. 21, 1912......	19.90	23.4	22.50	9,235.60
Lot C	March 19, 1913....	20.52	33.66	19.68	8,492.23
Lot D	June 5, 1913	30.43	37.90	23.04	13,147.10
Lot E	Oct, 30, 1913......	28.28	64.20	24.07	14,685.90
Total.......		101.04			$46,221.20

Up to the same date the small mill treated 1,975 tons of ore and with about 50 per cent. recovery produced bullion containing 1,272.44 fine oz. gold and 198.23 fine oz. silver, with a total value of $26,348.87.

Development consisted of a shaft 208 feet deep, with drifting of 247 feet at the 100-foot level, and 146 feet at the 200-foot level. In addition there is an open cut 65 feet in length and pockets and stations at the two levels.


TOUGH-OAKES MINE
Plan of Underground Workings as at Jan. 1st 1914.
VEIN No 2
Scale
10
0
20
40 FEET
100 Foot Level
200 Foot Level
NOTE: The drifts at the different levels are on the strike of the vein.
Surface
Shaft
OPEN CUT
Dip of Shaft 60° South.
Sump
Approx. Dip of Contact 45°
North
Ast.
LEGEND
Conglomerate
Porphyry
Subsidiary veins

Burnside

This property (claims Nos. L. 1821-3) adjoins the principal claim of the Tough-Oakes group on the south. Veins have been discovered near the contact of the porphyry and conglomerate. The principal workings are on the northeast part of claim L. 1823, where veins were exposed by deep trenches. No. 1 shaft was sunk on a vein which showed high-grade ore on the surface. The shaft is vertical, and the vein left the shaft at 60 feet down; at 80 feet a cross-cut was made N. 30° W. for 110 feet. A vein containing high-grade ore was encountered at 80 feet, which will be drilled on. The ore in the vein, where cut, is similar to that from No. 2 vein of the Tough-Oakes. Several narrow veins were also found in the southwest part of the claim which show high values on assay.

A narrow part of No. 2 vein in the conglomerate, Tough-Oakes mine.

Teck-Hughes

There has been considerable prospecting accomplished by means of trenching and underground work on this claim, No. L. 1238. No. 1 shaft, at the east side of the property, was sunk vertically 100 feet on a vein in the feldspar-porphyry, and a cross-cut of 23 feet was made to the south to the vein which dipped from the shaft. Drifts were run 70 feet to the east and 30 feet to the west on the vein. The vein is exposed to the northeast of the shaft. At one place there are about two and a half feet of quartz with porphyry inclusions, with an excess of quartz, while on each side there are one and a half feet of porphyry carrying quartz veinlets. The vein matter is lighter colored than that in the veins in the conglomerate.

No. 1 vein, Teck-Hughes, vein occurs in the feldspar-porphyry.

No. 2 shaft was sunk 40 feet on No. 2 vein in the conglomerate, which was traced 200 feet on the surface by trenching. At one point there is a width of 12 inches of vein material, consisting of quartz and altered conglomerate, which has a crushed appearance. The vein contains molybdenite, pyrite, and some visible gold.

No. 3 shaft was sunk in the porphyry to the 75-foot level, and a drift of 163 feet made easterly on a fractured zone containing quartz. Short cross-cuts were made at 50 feet and at 100 feet. A cross-cut was made to the north to intersect vein No. 2, in which there is ore where the vein was cut. At 163 feet in the drift a cross-cut was made to the south, where another fractured zone was encountered and which was being drifted on in March, 1914.

Wright-Hargrave

This property, claims Nos. H. R. 709-710, is situated at the east end of the south-east bay of Kirkland lake. The veins occur in the red feldspar-porphyry, and are comparable in structure with veins which are found in the porphyry in other parts of the area. In the north part of the claims there is a promising vein that strikes to the north of east and in which gold and tellurides occur. The vein filling consists of quartz, calcite, and included rock, together with molybdenite, telluride (altaite), pyrite, and other minerals. A shaft has been sunk to a depth of 78 feet, and the vein has been drifted on to the west for 60 feet and to the east for 55 feet.

Sylvanite (Wright and Robbins)

When this property, claims Nos. L. 2100-03, 2207, 2226, was visited in January, 1914, shafts were being sunk on two veins. On the Wright claim, No. 1 shaft was down 40 feet in the porphyry, where there is a fracture zone, showing quartz veinlets intersecting the porphyry. No. 2 shaft on the Robbins was down 20 feet, with conditions similar to those on the Wright. Gold could be observed in the vein matter.

Saw mill at Huronian mine, Beaverhouse lake, northeast part of Gauthier township.

Oakes

On this claim, L. 1857, a 40-foot shaft has been sunk on an altered part of a porphyry dike, which is somewhat greenish in color, and is intersected by quartz veinlets. Some drifting has been done on this fractured zone. At various places on the surface gold can be seen in the quartz veinlets and in fractures in the porphyry.

Shafts have been sunk on other properties, including the Wettlaufer (L. 16626), Wood (L. 1236), and Hunton (L.16621).

Gold in other Townships

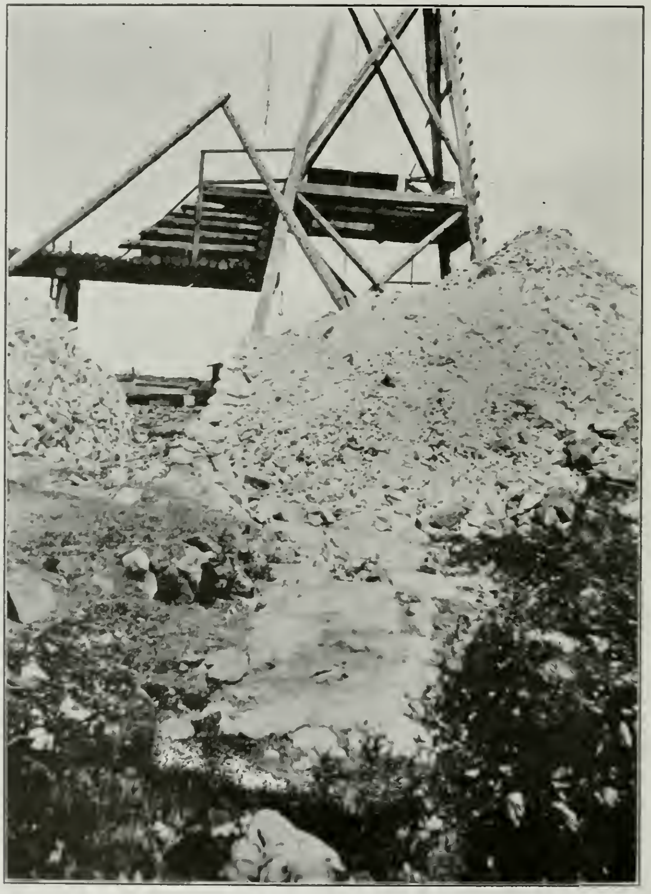
Morrisette township. On claims L. 2194 and L. 2202 (Costello), visible gold occurs in a zone of rusty carbonate impregnated with quartz. The country rock is amygdaloidal basalt, which is intruded by light-colored quartz porphyry.

Gauthier township. Gold-bearing quartz veins have been found in the northeast part of the township, just west of Beaverhouse lake, on claims now operated by La

Mine D'Or Huronia. The quartz veins are narrow, but gold can be observed at a number of places. Magnetite, iron pyrites and copper pyrites were observed in the veins. The country rock is Keewatin greenstone, which is intruded by narrow dikes of reddish porphyry.

Copper Ore

On a group of claims in Lebel and Teck townships the Dane Mining Company is prospecting for copper ore. Two shafts have been sunk on copper-bearing veins, and some ore has been shipped from the property.



Shaft on quartz vein, carrying copper pyrites. Dane Copper Mining Co., Lebel township.

Acknowledgments

The writers desire to express their thanks to the men who were in charge of the properties in the Kirkland Lake area when the country was being examined. Thanks are especially given to Messrs. C. A. Foster, Chas. O'Connell and M. W. Hotchkin, of the Tough-Oakes mine, from whom much information relative to the report was obtained. The assays and analyses, unless otherwise stated, were made by Messrs. W. K. McNeill and T. E. Rothwell, of the Provincial Assay office. Mr. W. R. Rogers, topographer, had charge of the production of the accompanying maps. The writers were capably assisted in the field work by the following gentlemen: Mr. R. M. Smith, Kingston; Mr. G. J. Smith, Kingston; Mr. R. W. Young, Bothwell; Mr. A. F. Mahaffy, Cromarty.

MAISONVILLE, GRENFELL AND EBY

A geological map of the townships of Maisonville, Grenfell and Eby accompanies the report on the Kirkland lake and Swastika gold areas (Map No. 23b).

The townships lie immediately to the west of the areas previously described. The geology of Maisonville, Grenfell and Eby is very similar to that of the Kirkland Lake and Swastika areas, and has been described in some detail in the marginal notes accompanying the geological map of the townships.

The predominating rocks are of the Keewatin system, consisting of basalt and andesite which have been intruded by diabase, the latter rock sometimes occurring in large volume. There are also some scattered bands of iron formation, particularly in Maisonville township.

The Timiskaming series has been traced from Teck township westerly into Grenfell and Eby townships as far as Kenogami lake.

A scene on Lower Twin lake, Maisonville township, showing a section of the Cobalt series in almost horizontal position.

The post-Timiskaming intrusives, with the exception of granite and syenite, are not nearly so widespread as in the townships to the east. There are a few dikes of lamprophyre throughout the Keewatin and the Timiskaming. On lot 4 in the fifth concession of Maisonville a lamprophyre contains numerous inclusions of greenstone and other rocks, simulating a conglomerate. This conglomerate-like lamprophyre has been observed at Cobalt and Kirkland lake. The granite and syenite are similar to the occurrences in the townships to the east. Feldspar-porphyry occurs only as narrow dikes. In one of these dikes on Wolf lake gold-bearing veins have been found.

There are rocks of the Cobalt series extending from Kenogami station westerly to Kenogami lake. On the east shore of this lake there is a minor unconformity in the Cobalt series. Fragments of a slate-like greywacké from the lower part of the series are included in a coarse conglomerate overlying the greywacké. This occurrence is similar to that on Obushkong lake, Gowganda.*

There are also isolated exposures of the rocks of the Cobalt series along the westerly side of Grenfell and Maisonville townships.

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* Report, Bureau of Mines, Ont., Vol. XIX, Part 2, p. 176.

Economic Notes

Gold

A number of narrow quartz veins occur in rocks of the Keewatin system and also in the intrusive reddish feldspar-porphyry in the township of Maisonville, and in Grenfell along the south boundary of Maisonville. Native gold has been reported in several veins on properties along the railway to the north of Sesekinika lake. Several shallow shafts or pits have been sunk on these veins in recent years, but during the fall of 1913 very little work was being done. There was, however, some activity in the vicinity of Wolf lake and in the area south of this lake toward Sesekinika.

The Dane Copper Mining Company was prospecting part of lot 5 in the fifth concession of Maisonville, to the east of Wolf lake. A great part of the work consisted in trenching on the strike of veins that had recently been discovered. On the north part of the property the country rock is amygdaloidal basalt, which is quite schistose near the veins. There are three parallel quartz veins, having a strike of nearly northwest and southeast. The veins occur in schistose rock that is highly impregnated with crystallized iron pyrites. A shaft has been sunk on one vein to a depth of 50 feet. About one-half mile to the southeast there is an outcrop of reddish feldspar-porphyry in which there are several quartz veins with showings of visible gold. One of these veins has been stripped for 400 feet. Masses of porphyry are included in the vein.

In September, 1913, a gold-bearing quartz vein was discovered on lot 6 in the first concession, Maisonville, just to the south of Kapakita creek. The vein, which averages less than six inches in width, has been traced for 150 feet. Some gold and iron pyrites were observed in parts of the vein. The wall rock is greenstone of a massive character, and has been little altered by secondary solutions.

Lead and Zinc

Narrow calcite veins, carrying small amounts of galena and zinc blende, have been found in the greenstone on the west shore of Wewegimok lake. To the south of Wolf lake there are several quartz-calcite veins carrying similar minerals. On claim H. R. 580, belonging to Mr. Dan Smith, of Sesekinika, one of these veins has been stripped or trenched for 200 feet. The vein, which is 14 inches wide at one place on the surface, carries a high proportion of galena and zinc blende. A shaft has been sunk 50 feet and several tons of lead-zinc ore have been piled up. The quartz has been deposited along the walls of the fissure, while the calcite, with most of the sulphides, has filled the centre.

Iron Pyrites

On lot 7, in the third concession of Maisonville, the iron formation is much fractured and impregnated with iron pyrites, pyrrhotite and a little copper pyrites. A sample of pyrrhotite on analysis showed a trace of nickel. The rock in the vicinity is greatly oxidized, and this locality is worthy of prospecting for iron pyrites, a mineral used in the manufacture of sulphuric acid.

More Recent Discoveries of Gold in Maisonville

A discovery of native gold and telluride of silver and gold in quartz veins was made early in June, 1914, on the Labine-Smith claims in the north part of lot 9 in the second concession of Maisonville township. The quartz veins have a general strike of N. 20° E., magnetic. The dip is generally to the west, but one vein with a width of two feet dips to the east. Some material carrying considerable native gold and telluride was taken from a narrow vein on the east side of the property. This vein, which at one exposure has a width of six inches, has been traced over several hundred feet by means of trenches. The quartz, which is of a milky white character, carries small amounts of iron pyrites, while at places the wall rock carries this mineral abundantly. An examination of some specimens shows the telluride and gold to occur in fractures in the quartz. The former mineral sometimes has a plate-like structure, and again may occur in small masses readily recognized in hand specimens. Some of the quartz has a comb structure.

An assay of the telluride by Messrs. Campbell and Deyell, Cobalt, gave the following results: Silver 43.3 per cent., gold 20 and tellurium 28.32. The balance of the sample is composed of impurities like silica and carbonate. The analysis corresponds to that of the mineral petzite. Another telluride also appears to be present.

The occurrence of tellurides in gold-bearing veins in northern Ontario is gradually being extended.

The veins occur in the Keewatin, which consists of ellipsoidal greenstone with intrusions of a coarse-grained diabase. There is a small feldspar-porphyry dike near vein No. 3.

On the Malouf claim (northwest quarter of the north half of lot 10 in the second concession), one-quarter of a mile west of the previously mentioned property, native gold has been discovered in quartz veins and oxidized wall rock. An excavation of 30 feet in length has been made on the deposit, which consists of narrow quartz veins dipping at a low angle to the west. The decomposed material from this cut was treated for a time in an arrastra located at the base of the hill near the railway track.

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